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Contents.

	PAGE
Notes and Comments	193
British Industries Fair (Birmingham)	194
Moulding Sand-Mill Pans	195
Correspondence	196
Book Review	196
The Manufacture of Steel Castings	197
Stellite	200
What is Semi-Steel?	201
A Charging Apparatus for Annealing Ovens	204
Blowholes, Porosity and Unsoundness in Aluminium Alloy Castings	205
The Manufacture of Manganese-Bronze Marine Propellers.—Part 2	208
Hints for Young Patternmakers	210
Electric Ingot-Stripping Cranes	210
Institution of British Foundrymen	211
Trade Talk	212
Iron and Steel Markets	214
Company News	216
Gazette	216
Personal	216

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NOTES AND COMMENTS.

Institute of Metals.

A London Local Section of the Institute of Metals has just been formed, with the sanction and financial assistance of the Council. The Chairman is Dr. O. F. Hudson, of the Admiralty Engineering Laboratory, and the Honorary Secretary is Mr. D. Hanson, M.Sc., of the National Physical Laboratory, Teddington. Membership is available to persons resident within fifty miles of the G.P.O. No subscription is required of members of the Institute of Metals, but non-members of the parent body, when elected as Associate Members of the Local Section, pay an annual subscription of five shillings. The first Paper to be brought before the London Section was that read on February 24, by Mr. O. W. Ellis, M.Sc., on "60: 40 Brass." On March 31 Mr. S. L. Archbutt is to read a Paper on "Aluminium Alloys," whilst on April 21 Dr. W. R. Ormandy will present a Paper on "Refractories." The London Section already has a membership of over 200, and is proving a valuable meeting ground for metallurgists and engineers who wish to meet and discuss technical problems at more frequent intervals than is practicable in the case of the parent institute.

Fontoid?

It is generally agreed that destructive criticism, unaccompanied by constructive proposals, is useless. Wherever semi-steel is discussed unanimity is shown that such a word is a gross breach of the laws of nomenclature; but usually no alternative is suggested. We recently unavailingly pleaded for the retention of the word on the ground of common usage, and that at least the word could be looked upon as an adjective qualifying the noun cast-iron. One of the objections raised was that the word "semi" gave the impression that the constitution of semi-steel cast-iron was half steel, and as it was manufactured from mixtures containing from 10 per cent. to 100 per cent. steel scrap, therefore our suggestion could not be supported We have decided to submit to our readers the coined word "Fontoid," which has been evolved from the French word "fonte," meaning cast-iron, and the Greek termination "oid," meaning "resembling." A translation of the current French expression for semi-steel is "steely cast-iron," which shows an improvement on the English insomuch as the base word is a correct appellation.

The Heat Treatment of Castings.

An exceedingly important contribution to the study of the influence of heat-treatment on steel castings has recently been made by Dr. Giolitti, the distinguished Italian metallurgist. An extract from one of his researches, which appeared in the last issue of THE FOUNDRY TRADE JOURNAL, points out the properties of steel are due to the distribution and continuity of the structural constituents rather than to the specific properties of the constituents themselves. To our mind this statement brings up for reconsideration many interesting results which have been "scrapped' is being nonconcordant with the results obtained by the majority of investigators. We take Dr. Giolitti's statement to indicate that ingotism and stresses brought about by "thick and thin" sections in a casting have such an extremely important bearing on the mechanical strength of steel as to warrant all important castings undergoing a short heat-treatment. Evidence that this applies to both semi-steel and cast-iron is furnished by Mr. Field on page 203, where a 10 per cent. steel mixture shows an increase of 10 cwts., and normal grey-iron invariably 1 ton after a simple heat-treatment.

Researches.

Foundrymen are often meeting with troubles which could be avoided if care were taken to avail themselves of published research work. We find it to be common practice to investigate carefully all "wasters." Whilst this is desirable, we consider it preferable to carry out and tabulate inexpensive researches continuously on all products, good and bad. For instance, how many steel foundries have established for themselves a density quotient based on Brinell's researches? A running research of this nature will often enable the steel-maker to establish immediately the cause of a rejection. Then, again, the various formulæ for ascertaining the tensile strength of steel from its chemical composition, when once established under definite works conditions, are of great utility in dealing with abnormal specifications or tracing "freak" results. In the iron foundry a chart showing the results obtained daily from Keep's test will prove to be extremely useful in checking cupola mixtures.

Change of Date.

Prof. Turner's lecture on "Carbon in Iron and Steel" will be given before the Coventry Branch of the Institution of British Foundrymen on March 15, instead of the previously arranged date.

XUM

British Industries Fair (Birmingham).

An integral part of the Board of Trade British Industries Fair organised by the Birmingham Municipality Chamber of Commerce, and held concurrently with the British Industries Fairs at London and Glasgow, was formally opened on the 21st instant, and will remain open until March 4.

The Exhibition held last year was thoroughly representative of the many and varied interests of the district, and from every point of view the initial venture was a signal success. The present Fair, however, bids fair to go one even better. There will be much to interest the practical foundry manager in the matter of foundry production, though naturally the exhibitors of foundry plant and equipment are not numerous. The principal exhibitors in this section are the following:—

W. & T. Avery, Limited, Birmingham, have a very imposing exhibit, comprising three large weighbridge "office works" as fitted to the largest road and railway weighbridges. One with steelyard arranged with graduations in two different national standards: one with the latest no-loose-weight type of steelyard; one with device for printing the weights. All three are graduated to the full capacity of the weighing machine, to which they would be fitted without the use of loose proportional weights.

In the automatic section are shown:—(1) Automatic grain weighing machine. (2) Small tram weighbridge fitted with Avery totaliser, which automatically weighs the wagon immediately it arrives on the machine, and shows the weight. Immediately the wagon is wheeled off the machine resets itself for the next weighing. (3) Automatic liquid weigher shown working.

The exhibits also include:—

Impact tester, latest 30-ton vertical testing machine, machine for testing piston rings, machine for testing hardness of metals, spring testing machine.

Machines are exhibited for counting accurately and quickly all small parts, repetition work, etc.

The Monometer Manufacturing Company, of Savoy House, London, are showing a number of their specialities. Among these is their patent white-metal melting furnace for the production of all kinds of small and intricate parts in lead, tin, white metal, and zinc alloys, and which are being used by the principal engineering and motor manufacturers in this country for the production of all kinds of motor bearings and other parts.

For melting brass, copper, gun-metal, etc., the large 300-lbs. lip-axis tilting furnace is shown fitted with the Manometer patent oil-burning apparatus and a plumbago crucible, while for melting aluminium there is their special iron-pot furnace, the one shown being of 500-lbs. capacity, and fired by oil.

The Midland Fan Company, Limited, Birmingham, have a stand consisting of complete spraying plant suitable for painting, enamelling, lacquering, varnishing, etc., of ordinary medium-sized work, and are glad to give information concerning the possibilities of adapting spraying for the application of these materials in the manufacture of any class of goods for which it may be suitable. This firm say that they have installed plants for painting or enamelling for all classes of articles from buttons to airship sheds. In many cases the saving both of material and time is quite revolutionary to the trade concerned. The cost of a painting job has been known to be cut down to 5 per cent. of an original estimate.

Stansell's Acetylene Company, Limited, Exeter, are showing the following acetylene apparati of types numbers 1 and 2 and "Farm," oxygen regulators, blowpipes, cutting blowpipes, welders, pre-heating furnaces.

Demonstrations of welding will be carried out every day. Samples of welded annealing boxes, welded wheel-barrow frames, welded domestic kettles, welded petrol tanks, welded boxes, acetylene flare lamps, acetylene lighting plant, welded pipes and branches are shown.

Adaptable Moulding Machine, Birmingham, are giving working demonstrations of the latest designs of moulding machines, which embody a number of distinct improvements in construction. These alterations in design are the outcome of experience gained in the past, and which will give further satisfaction to users. Renewable gun-metal bearings, with plumbago rings inserted, have been fitted, and all parts of the machines are being made to jigs and gauges, so that replacements can be speedily made in case of breakages. Machines are shown fitted with the various types of attachments for handling varying classes of castings. The exhibit includes a new type of core machine recently developed for handling core-boxes of a complicated type such as gear-box work for motors. These machines will be made in various sizes to meet the needs of the foundries that have moulding machines installed but who are usually being held up for cores. Existing core-boxes can, in most cases, be fitted to the machine in a few minutes. The movement is of an extremely simple design, and so arranged that the sand cannot clog the mechanism. Adjustments are provided to meet the varying sizes of core-boxes, and quite a large range of work can be made on the machine. Core machines of the "piston" type are also shown in operation. A large variety of castings that have been made on the moulding machines are shown, so that prospective customers can make comparisons of the productions with other machines on the market. Other features are moulding boxes (cast iron and steel), snapflasks and sand-mixers, which embody the latest improvements in this class of foundry plant. Roller bearings are provided in these machines which take up all the end thrust—a very important factor in the successful running of such machines. The machines are made up with and without adjustable reels to suit the varying needs of foundrymen.

The Pneulec Machine Company, Birmingham.—Electrically operated jar ram moulding machine, self-contained, complete with pattern-drawing mechanism, unusually efficient jar, perfectly steady lift, adjustable to stop at any height up to 10 ins., and operated by two levers only. It is designed to work under heavy foundry conditions, and the jar can be adjusted to suit moulds ½ cwt. to over ½ ton.

The "Pneulec" machine is entirely independent of air compressors and the like, being operated only by electricity.

The capacity of the machine is also unlimited. It is possible to obtain with suitable labour anything between 40 and 200 moulds per day, depending, of course, on the size of the box used.

The machine is absolutely self-contained. It is also quite fool-proof. When the height required has been attained for the lift, a special trip lever arrangement throws the gearing out, and the lifting immediately stops. Every working part is protected, and the gearing runs in oil.

The action of gravity is greatly assisted by the "suck back" of the piston descending in the cylinder, this creating a partial vacuum which exerts a downward pull on the table of the machine. The advantage of this action is obvious in comparison with other machines of the jar ram type. In a machine without this "suck back" a mould of light weight would take longer and more "bumps" required to make it firm than a mould of greater weight.

The actual cost of consumption of electricity per hour for operating (ramming and lifting) from test has been proved to be only 1¼d. per hour, using a moulding box 24 in. × 22 in. × 12¾ in., and weighing, complete with sand, 4 cwt. There are three methods of altering the intensity of the jar.

The method of operation is briefly as follows:—The pattern plate is bolted to the table of the machine, moulding box is put into position and filled with sand, the ramming lever is then drawn sharply into position, which starts the jolting motion. When mould is sufficiently rammed the lever is moved back again to its original place, *i.e.*, neutral, the surplus sand is strickled off, plate rapped and the lifting lever put smartly into engagement, and the mould lifted clear of the pattern. The height of lift is adjustable to a maximum of 9¾ in. The lifting apparatus is set to the desired lift before starting job, and is automatically thrown out when required height has been attained.

Moulding Sand-Mill Pans.

BY A. B. SMITH.

There are four methods by which sand-pan castings are made, depending upon the number required, the tackle available, and the design of the pattern.

Fig. 1 is the most popular method, providing that three-part boxes are available. In this case a ring pattern and a loose bottom made of suitable boards are used. The following is the usual procedure :—

The drag box is set level on the floor and rammed up to the first joint. Two bricks are inserted in the middle of the box, which are withdrawn later, which leaves an aperture for the coke

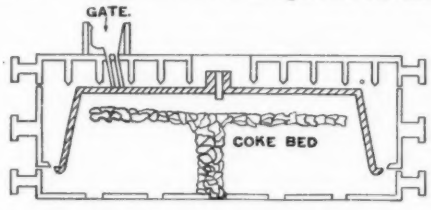

FIG. 1.—SHOWING METHOD EMPLOYED WHEN A 3-PART BOX IS AVAILABLE.

vent. The ring pattern is next placed in position and centred, when it can be knocked down to the edge of the rib of the pan, and the joint made around the outside. The middle box is placed in position, when the ramming up can be commenced, and it will be observed that by using a ring pattern the outside and inside can be rammed up simultaneously. Before the top is reached a layer of coke is laid in and trained down the centre for the "air" to escape through the bottom box. The centre is lightly rammed up and strickled off to allow of the laying in of the loose boards forming the bottom. The second joint is now finished off and the top box is put on.

As this is only an ordinary flat top it needs no comment, with the exception of runners and risers on the top-plate, as shown, and a single riser off the boss, this being the highest point. For stripping, the top is taken off and the boards removed. The middle box is next lifted off and the pattern withdrawn. After the mould is finished off and blacked it is re-assembled.

Fig. 2 shows a method wherein only a top-box is available, and a whole pattern is used. In this case a pit is square dug, about 18 in. larger than the width of the top of the pattern and 18 in. deeper to allow of the making of a coke bed. When the coke bed is covered with sand

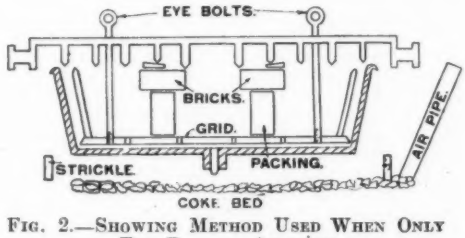

FIG. 2.—SHOWING METHOD USED WHEN ONLY A TOP PART IS AVAILABLE.

and rammed up, two straight edges are bedded in and a level bed "struck off." The pattern is set upon this, the top of the pattern being level with the floor or top of the pit. The ramming-up of the outside is proceeded with until the top joint is reached.

The middle is next proceeded with, a "grid" is made as shown, and provided with four nuts cast in for the purpose of attaching eye-bolts. A layer of facing-sand is laid in, and the grid, after being well clay-washed, is placed in position by means of the eye-bolts and centred. After the grid has been well "tucked," bricks are placed on the grids, and brought up level with the top to act as packing, and to prevent the grid from "sagging" or slipping when being turned over. The inside being rammed up, a joint is made around the outside edge and the top box placed in position. The brick-packing can now be wedged up to the bars or stays of the box. On completion of the ramming the eye-bolts are fastened to the top of the box, and the box corners are staked. The top is now removed and turned over for finishing. After withdrawing the pattern the

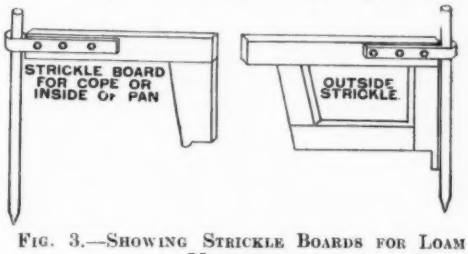

FIG. 3.—SHOWING STRICKLE BOARDS FOR LOAM MOULDING.

bottom is well "pricked" and the mould re-assembled.

Loam Moulding.—This is a very simple operation, and where loam moulding is in practice it is also advantageous, as the tackle required is generally available. The strickles shown in Fig. 3 is all the pattern-making required. Top and bottom plates and a ring or inner plate for the centre are necessary. The bottom-plate (the outside) is first struck up, being levelled on a

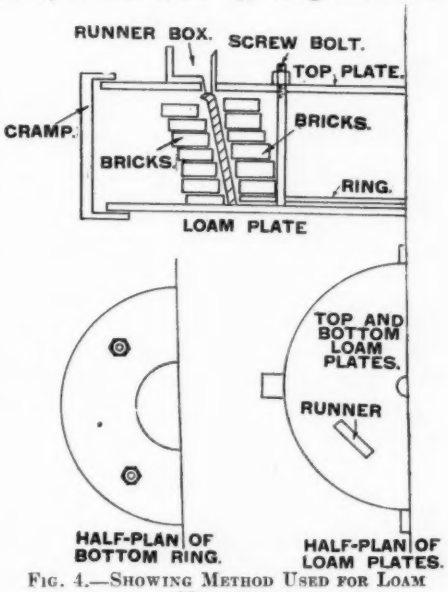

FIG. 4.—SHOWING METHOD USED FOR LOAM MOULDING.

tripod. The strickle board and spindle are stood in position and a layer of loam is placed on the plate. A course of bricks is followed round within an inch or two from the edge of the strickle. The whole of the outside is built up in this way until the top is reached, when the inside can be roughed up and finally finished off with a face of thin loam. The inside is treated in the same manner, except that allowance is made for the "ring" plate which carries the centre mould when turned over and placed in position and finished off as shown in Fig. 4.

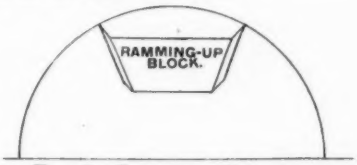

FIG. 5.—SHOWING A RAMMING-UP BLOCK.

A further method, which is generally used in jobbing foundries in the event of there being only one to make. A bed is made in a pit, as in Fig. 2, and a ramming-up block, shown in Fig. 5, of the "inside" diameter and depth of the sand-mill pan. This is set on the bed and the outside rammed up, the block being worked round as a strickle board would be until the circle is completed. When rammed and taken out the thickness is cut out with a strickle board, the result and assembling being the same as in Fig. 2.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

THE CASTINGS TROUBLE.

To the Editor of The Foundry Trade Journal.

Sir,—The letter of "Manager," under the above heading, which appears in your issue of February 10, is a big improvement upon his previous attempt, for in this he comes to business, and I can afford to allow him any little amusement he can get from my remarks. The issue is now considerably narrowed, for he confesses that *all* buyers are not avaricious, whilst I certainly did not imply that all founders were "black sheep."

I regret that I am unable to share his optimism regarding the continued prosperity of the industry, as already in many quarters the pinch of the general depression is being felt. No one (even a buyer) wishes to see the industry in difficulties, and there is no necessity for that to happen, if amicable *business* relations exist between the contracting parties.

I am obliged to "Manager" for his further explanation of the "knock off" system, and he may rest assured that I, personally, shall not take advantage of the information bestowed. In this respect, however, I should like to say a word on behalf of the buyer as an individual. He, of course, buys to meet the requirements of his factory, and he must heed what is said concerning the goods he secures. If the shops inspector issues an adverse report notice must be taken of it. It does not follow that the piece in question is scrap, or even unusable, but it is not to specification, and so the foundry must be advised. No attempt is made to introduce the "knock off" system in regard to this, but if the foundry will not accept the warning, and persists in sending similar castings, then the buyer, in self-defence, must take action, and so the foundry is penalised.

The buyer gains nothing by attempting to beat down the price by threatening to return the casting. The shop inspector is not concerned with the price, but he is concerned with the accuracy of the casting, and in the factory where machining operations are planned, and definite rates fixed, it follows that any inaccuracy which upsets either of these calculations must necessarily be commented upon.

I do not think I need say anything more, except to thank you for the opportunity of answering the points raised by your correspondent, and to express the hope that the founder and the buyer will co-operate, and thus ensure the continued prosperity of the industry.—Yours, etc.,

"A Buyer."

To the Editor of The Foundry Trade Journal.

Dear Sir,—The article of "A Buyer" and subsequent correspondence in your columns between this gentleman and "Manager" have, to use an Americanism, tickled us to death, as they are so extremely typical of the whole situation in the foundry trade. We should like to say, before going any further, that our sympathies are mainly with "A Buyer," and although we are iron-founders ourselves, are convinced that the situation being as it is, is the result of foundries in this country having made no efforts to keep up to date in the past. To instance one item only, that of the installation of moulding machinery. How many foundries are there to-day who know anything about machine moulding, or, if they do, have equipped themselves properly for it? To purchase a moulding machine was looked upon as solving the whole labour problem, so one was bought, and all and every sort of work, in the majority of cases, crowded on to it, although it might have been of a class totally unsuited for that type of machine. Then as the goods were not delivered, mechanical moulding was condemned. Another item was that moulding machine operators were classed as unskilled labour, whereas a properly trained machine moulder is as much a highly skilled man as a lathe operator.

We ourselves are conversant with American, Canadian, French and Belgian shops, and in our opinion English shops are, on the average, miles behind in equipment, in spite of the fact that they have at hand the best workmen in the world.

Another item is costing. How many shops in this country know the cost of each job accurately, or even moderately accurately? The prevailing custom is to average their cost per ton, and sell on this basis, and no more unsound economic principle could be imagined. Costs are vital in any industry, and are no more difficult to obtain in our trade than any other.

Yours, etc.,

V. Jobson.

Derwent Foundry Company, Derby.

Book Review.

Coal, Iron and War, by Edwin C. Eckel. London: George G. Harrap & Co., Ltd. Price 12s. 6d.

In tracing out the stages of industrial development, the author chiefly lays stress upon the growth of the coal and iron industries, not merely because of their basal character and importance, but because such limitation aids in giving definiteness to the study, and for another reason which is later disclosed—that coal and iron are the essentials of successful warfare. The author covers an immense amount of ground in dealing with the four parts into which the book is divided. Part I. deals with the growth of modern industrialism in England, America, Germany and France, refers to the recent war, and attributes its outcome to the vastly greater coal and mineral resources of the Allies, including America, as compared with those of the Central Powers. In Part II. Mr. Eckel indulges in a good deal of speculation as to the coal, iron ore and other mineral resources of the world. Its coal resources he places at about 4,400 million tons, and remarks that even from the most pessimistic standpoint no trace of general exhaustion need be feared for centuries. However, as the coal supplies of certain manufacturing districts and of certain countries are further advanced towards exhaustion, then are those of some existing or possible competitors, there are likely to be changes in the relative importance of manufacturing centres, and gradual but certain changes in kinds of industry practised. The author gives the United States petrol resources left in the ground—an extremely hazardous forecast—as 6.730 million barrels. The American output in 1918 was 356 million barrels, so at that rate their oil supply should be exhausted in less than 19 years, though it is likely that the expected deficiencies in output would be met by greatly increased production in Mexico, Venezuela and Columbia.

The author estimates the iron ore resources of the three best known Continents, namely, North America, South America and Europe, as 35 billion tons, which at the rate of consumption during 1913 will ensure the world demand for the next 200 years, though to allay any anxiety as to future supplies he recalls another small item of some 57 billion tons expected from Asia, Africa and Australia, *if we assume* they will yield iron ore about in proportion to their land areas.

Part III., amongst other things, deals with facts of industrial evolution, the progress of invention and the rise and fall of prices, while some pages are devoted to the development of the corporation and to legislative helps and hindrances. Under the heading of "The Future of Industrialism," the author discusses in Part IV. a number of the factors relating to world competition, and holding the rank of Major in the American Army, he is tempted to digress from his point to suggest the possibility of war; and this reminds us that the whole book is written from the American standpoint, and whilst enumerating the resources of all other countries, the ultimate object appears to be to throw into relief the vast resources of the United States. It is rather disturbing to know there "may be war between Japan and the United States or Australia, because these three nations have individual aims which are hard to satisfy peaceably," but we are glad of Mr. Eckel's assurance that such a regrettable incident would not be serious.

The Manufacture of Steel Castings.*

By D. D. MacGuffie.

Steel castings are generally made by the Siemens, Tropenas, Stock converter, electric, or crucible processes. Siemens furnaces are used for castings varying from 1 cwt. and upwards. Undoubtedly castings giving excellent tests are made by this process. Usually all Siemens steel is stopper poured; some is, however, shanked, but 2 cwt. is the minimum that can be dealt with with safety and without skulls. The lecturer was of opinion that sufficiently high casting temperatures were not obtained, thus rendering the process more suitable for heavy castings, such as hydraulic rams, cylinders, ship castings, and general heavy work. If the steel is made to the required analysis and cast at the correct temperature it gives a metal very easy to handle.

Two hundred and fifty boxes have often been cast from a five-ton Siemens furnace. There are many experienced foundrymen to-day who are thoroughly *au fait* with moulding, but who on hearing the steel maker referring to the constituents of steel, are quite lost. The lecturer, therefore advised every foundryman to study steel processes and analyses required for any particular specification. Having done this he can intelligently criticise all operations from the manufacture of the steel to the finished casting.

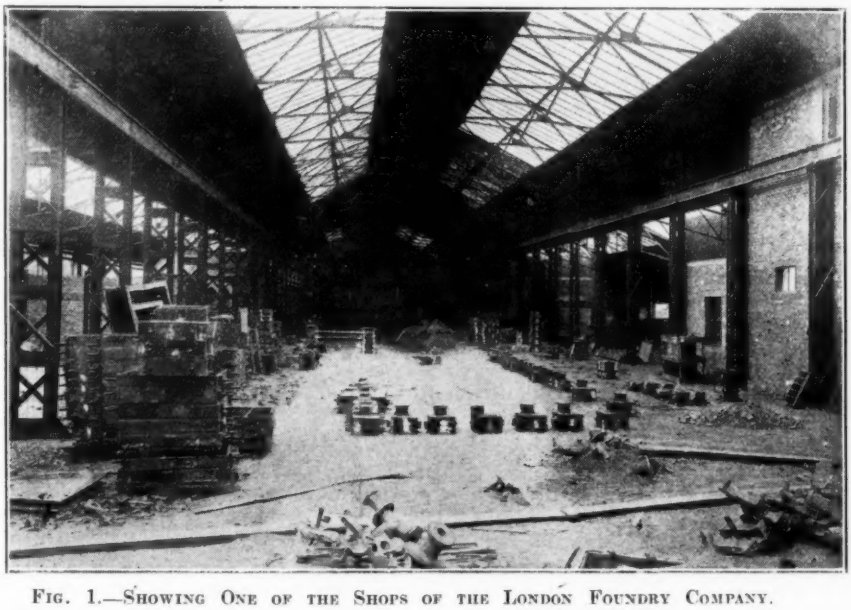

FIG. 1.—SHOWING ONE OF THE SHOPS OF THE LONDON FOUNDRY COMPANY.

The Tropenas Plant.—The Tropenas plant is more adapted for lighter castings of the ordinary type rather than for high class work. Some firms, however, do produce first quality castings from converters. The quality of Tropenas steel depends on the hematite and the sulphur in the coke. The blower can seriously influence the quality of the finished product, for it is quite easy to misjudge the completion of the refining. If underblown a steel high in carbon is produced, and if it is overblown the steel is wild. This process produces steel at a fairly high temperature. The vessel is, externally, not unlike a Bessemer converter, and consists of a steel shell in three parts, which comprise the mouth, body and bottom part. The three parts are fastened together by means of cotter bolts. The converter itself is mounted on trunnions so that it can be tilted to any required angle.

The lining usually consists of silica bricks; some people, however, inadvisedly employ ganister. Obviously with a silica lining it is an acid process. The bottom of the converter bath is tapered so as to expose a considerable surface of the metal to the air blast. The twyers are at such a height that when the converter is vertical they should be just beneath the surface of the metal. It is most important that the metal should be below the twyers to avoid the destruction of the lining by the backwash during blowing, and to minimise the danger of the filling of the twyer-box with metal. To have sufficient metal and converter horizontal before commencing to blow is an essential.

The lecturer, who condemned very small hand-tilted converters on the ground of insufficient body of metal to adequately retain heat, insisted that too much attention cannot be given to the choosing of the cupola. The cupola, which gives the right quantity of hot metal when the converter is ready to receive it, should be independently blown. The lecturer pointed out the absolute necessity for modern handling arrangements.

The process of making Tropenas steel is as follows:—After heating up the converter to a white heat with coke and a reduced blast, the converter is tilted to a variety of positions to ensure uniform heating. The vessel is thoroughly cleaned, as any coke left in the converter after charging in the molten iron will cause endless trouble with the carbon flame and will not improve the resulting steel. The correct quantity of molten iron from the cupola having been received, the converter is raised to such an angle that the air blast from the twyers plays upon the surface of the metal. When the evolution of carbon mon-oxide becomes rapid, the vessel is turned a little more upright and air is sent through from a second row of twyers so as to burn the carbon mon-oxide evolved, to carbon di-oxide within the converter, obviously increasing the temperature. At this period the pressure is increased to about 3½ or 4 lbs. per sq. in. The silicon flame next appears simultaneously with a violent reaction inside the converter, which, if not controlled, a quantity of metal is liable to be lost by being projected from the mouth of the vessel. The blast pressure and inclination of the converter must be adjusted according to the reaction. The flame having died down a little, the carbon flame begins to show very prominently, easily recognisable by the purple colour on the edge. Close attention must be given to the flame until it gradually dies away and appears to be about from 6 to 12 inches from the mouth of the converter. The vessel is now partially tilted, the blast shut off, the necessary alloys added and the metal is teemed. It was suggested that if a carbon of 0.3 to 0.4 per cent. was required, hot molten iron from the cupola should be added to effect the required recarburisation.

Stock Converter.—The Stock converter gives a

* Extract from a paper read before the Sheffield and London branches of the Institution of British Foundrymen.

similar steel to acid Siemens, but perhaps slightly better owing to its fluidity and to the lower sulphur and phosphorus content, which renders it more suitable for high class intricate castings. Some extremely thin castings which were bottom poured have been made by this process, but a good teemer is an essential.

The more important features of this plant are that no impurities are introduced by the oil fuel, the cupola is dispensed with, and a regenerative system is incorporated.

The Stock converter is lined with 9 in. shaped silica brick, with a backing of ground ganister to clear any bolt or rivet heads. As in general converter practice, the brick work joints should be as close as possible in order to diminish the liability of the extremely liquid steel to break out. The converter, which is mounted on trunnions, is fixed to a base plate resting on a roller path; attached to this is gearing which enables the converter to be turned round to any position both for charging and melting.

The blast capacity of a 3-ton Stock converter is 3,000 cu. ft. per min., and is furnished from a Roots blower, driven by a 100-h.p. motor at 600 r.p.m. Blowing pressures vary considerably on account of melting and refining being conducted in the same vessel; for melting only ¾ lb. pressure is required, but when converting into steel 3½ to 4 lbs. per sq. in. pressure is taken. The blast arrangements are entirely different from the ordinary side or bottom blown converters as it enters by a main passage through the bottom plate in order that the converter may be horizontally rotated. The blast then passes through one of the trunnions into the blast box placed at the side of the converter.

The oil burners consist of small removable tubes placed into the twyer holes. 40 lbs. pressure is maintained by means of a small pump, which feeds oil direct from the storage plant to the burners. The pumps are regulated by a hand valve. An economiser serving to recover waste heat resulting from the combustion of oil during melting consists of a series of ribbed cast-iron pipe of U-section, through which the blast passes. The heat from the converter passes into the economiser and circulates around the U-shaped pipes and so heating them. The cooled gases then pass up the chimney stack, having given up sufficient heat to raise the temperature of the blast to 425 deg. C.

The lecturer considered the manipulation of a Stock converter so simple that any intelligent man would be skilled after a month's training. The lining should be dried by means of a slow coke fire for at least twelve hours. The sequence of operations before charging is as follows:—The oil burners are placed in position, the blower started up, and the oil cock turned on. The heat of the lining ignites the crude petroleum. A pressure of ½ to ¾ lb. is maintained for a period of 30 to 40 min., at which time the thermometer should show the air blast is at about 360 to 375 deg. C. The converter is now ready for charging, but before turning the vessel round to charging position all oil and blast should be shut off. As scrap steel has a higher melting point it should be put in after the pig-iron, as in such a position it meets the full force of the oil flame. When the converter is charged it is turned round to such a position that it works in conjunction with the economiser. After starting up the blower, the oil is turned on and melting is conducted at ¾ lb. per sq. in. After about an hour the oil and blast are shut off, the converter turned round to loading position, and the charge is rabbled. Another 20 minutes melting should give a bath sufficiently hot for converting into steel. The oil-burners are removed, and the surface of the bath is kept at such a position that it is level with the bottom of the twyers. The blast box is rendered air-tight by the insertion of dummy plates into the oil burner holes. The blowing is carried out in the same manner as any other side-blown converter. The lecturer was of opinion that only electric steel, being more free from impurities, is superior to Stock converter steel for castings.

Table I. gives the analysis and tests of Stock converter steel.

Fig. 2.—Showing the Machine-Moulding Shop at the London Foundry Company.

Table I.—*Analysis and Tests from Stock Converter Steel.*

Analysis.				
C.	Si.	Mn.	S.	P.
0.33	0.32	0.46	0.015	0.046
0.43	0.33	0.75	0.017	0.043
0.21	0.28	0.65	0 015	0.043
0.30	0 29	0.54	0 014	0.041
0 21	0 28	0 72	0 011	0 018

Physical Tests.		
Max. stress. tons per sq. in.	Elong per cent. on 3 in.	Bend test.
35 2	20	125U
39 0	20	180B
31 8	30	180U
35.0	34	112B
120 4	32	90U

The Electric Process.—Though considered by some to be still in its infancy, the electric furnace has established its position as an ideal plant for the manufacture of steel castings. Its ability to produce steel of any desired composition and to teem it at any point within the useful range of temperatures are two of the more important factors. The only factor which mitigates against its general adoption is the extremely high price charged for electric current.

The electric furnace can be either acid or basic lined, and the lecturer advocated the former for obtaining output, and the latter for the manufacture of high-class material, on account of the facility which it affords for almost entirely eliminating the two dangerous elements, sulphur and phosphorus. As the lecturer had previously dealt with the structure and lining of the basic electric furnace, he did not propose to again cover the ground. The furnace is first heated by arcing upon broken pieces of electrodes or coke distributed over the bed of the furnace. The furnace is tilted and all broken electrodes are removed; any carbon remaining on the hearth causes trouble when oxidising the carbon out of the bath Before charging the furnace, lime is added and is scattered all over the hearth. Iron ore is next charged in, and, if using any heavy scrap, this should be next added, taking care not to place

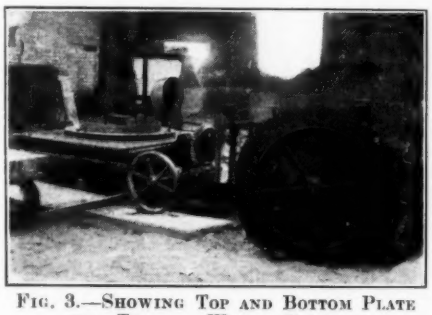

FIG. 3.—SHOWING TOP AND BOTTOM PLATE FOR TRACTOR WHEEL CASTING.

large pieces directly under the electrodes, in order to avoid heavy surges of current when starting up. As many turnings as possible are charged up for the purpose of protecting the furnace walls. Current is now switched on and arcing is maintained. The type of slag indicates whether the carbon is eliminated; an excess of carbon in the bath gives a dark brown, whilst low carbon, say 0.09 per cent., produces a dark grey slag. When such a condition is reached the bath is ready for being slagged off, providing the temperature is sufficiently high. A standard ½-in. bar is usually employed for ascertaining this.

The chemistry of the oxidising slag was next touched upon, the lecturer stating that the phosphorus was oxidised to phosphoric acid and combined with the lime present to form soluble calcium phosphate. The carbon in the bath was stated to be oxidised to carbon monoxide, which could be seen passing away from the furnace, through the electrode orifices, as a brown gas. The silicon in the bath is oxidised to silica, which becomes part of the slag. The percentage com-

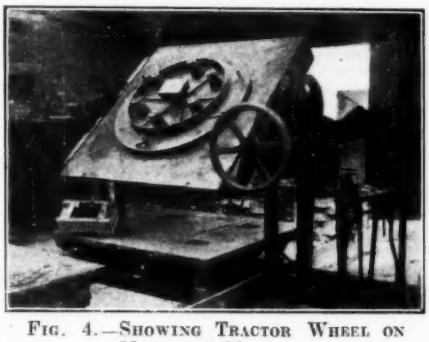

FIG. 4.—SHOWING TRACTOR WHEEL ON MOULDING MACHINE.

position of the bath is normally as follows: Carbon, 0.09; silicon, 0.01; manganese, 0.02; sulphur, 0.04; and phosphorus, 0.01. The dephosphorising slag is completely removed, and 80 per cent. ferro-silicon, lime, fluor spar, and a little anthracite coal are added. Arcing is again resumed and reducing conditions set up. The various reducing elements acting upon the bath and slag change the colour of the latter from black to enamel white. Bar tests are taken as a check upon the temperature, and spoon samples for deadness. Should the bath be wild, ferro-silicon is added in weighed quantities until such time as the eye indicates the bath is dead. The carbon is adjusted by pig-iron additions, with allowances being made for the carbon introduced by the spiegel (used for bringing in manganese) and an 8 per cent. melting loss. Obviously, final additions should be made under a white slag to ensure a maximum yield. When the steel is sufficiently hot and quite dead it is teemed in the usual manner. If rusty turnings are used anything up to 25 per cent. melting loss may be obtained.

When discussing the chemistry of the reducing period, the lecturer stated that under an atmosphere of carbon monoxide the conditions are favourable for reducing sulphur in the form of calcium sulphide, which is insoluble in iron but dissolves readily in an oxide-free slag; this slag, as is well known, falls to powder when exposed to the atmosphere. Unless white slag conditions

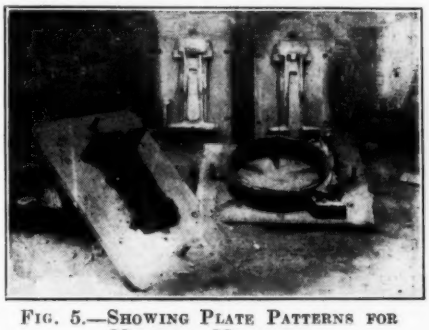

FIG. 5.—SHOWING PLATE PATTERNS FOR MOULDING MACHINES.

are maintained the sulphur will pass back from calcium sulphide into the steel as sulphide of iron.

The Moulding of Steel Castings.—The making of moulds for steel castings was at one time a very difficult matter, a perfect casting rarely being obtained; amongst the faults appearing were cracks, pulls, bad surface, distortion, and blowholes. The lecturer was of opinion that a good surface should result if an ordinary steel casting is made from a steel of the following analysis: Carbon, 0.25 per cent.; silicon, 0.25 per cent.; manganese, 0.65 to 0.75 per cent.; and using a refractory sand high in silica and as free from alkalies, as possible, and assuming the mould is rammed hard and correctly run. The casting of automobile wheels requires considerable study, and running straight down the boss in two places, thus allowing of a more even flow and cooling was advocated. Another type of troublesome casting is hydraulic cylinders with large bases and awkward necks; these are usually run from the bottom with a double spray, resulting in the cold metal

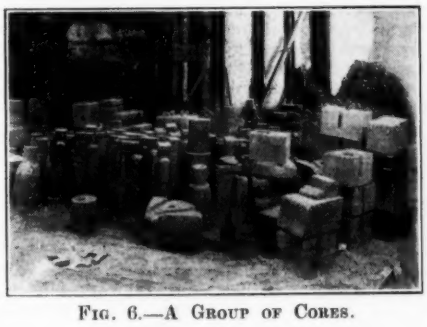

FIG. 6.—A GROUP OF CORES.

being unable to feed the hot metal at the base. Obviously, the consequence is that cracks and pockets are sufficiently in evidence to fail the casting under test. It was suggested that by giving a reasonable fillet at the neck, and running the steel into a tundish provided with four 1 to 1¼ in. round holes, and casting straight down, better results are obtained. The slower teeming exerts less pressure, feeds continuously, and leaves the hot metal in the most necessary place.

Objection to such a method might possibly be raised on the grounds that the metal has a considerable drop, but by the use of wire nails on the surface around the bottom and a few inches

XUM

up from the bottom of the core, will prevent any washing or scabbing, while blanks can be similarly run by arranging a dish or bush on the top of the centre boss, provided with two holes, so placed that in teeming, the stream will miss the centre core. If a spinning runner or even a double spray runner is used a central shrinkage cavity, about 6 ins. from the runner where the root of the tooth is cut will be found, on account of the hot metal being there last. Owing to the high price of steel castings, the designer is placing the foundryman in a very difficult position, as he cuts down the machining to a minimum; where $\frac{1}{4}$ to $\frac{3}{8}$ in. was previously allowed on buffer and spring castings only $\frac{1}{8}$th even 1-16th in. is now allowed. The lecturer pointed out that an insufficiency of machining allowance equally affects the buyer, as the returning of castings to the maker also holds up his (the buyer's) production.

In a works where patterns are made, little trouble is experienced, but where they are made by an outside pattern-maker, although the usual contraction is allowed, difficulties often arise; for instance, the London omnibus spider wheel gives a contraction of about 1 in 120. If the ordinary contraction is allowed the outside diameter will be far too great. The contraction on a casting made in green sand mould presents many peculiarities. A plain ring, 4 ft. 6 in. in diameter, on which there has been allowed 3-16ths of an inch for machining, and cast in green sand or a skin dried mould, it will be found that it is too small for machining.

Machine Moulding.—It is universally accepted that machine moulding is essential in the modern foundry. Moulding machines increase coremaking, but in a well-equipped machine shop where stripping plates and loose pieces can be made, much coremaking can be dispensed with. The lecturer was of opinion that the better known makes of British moulding machines, such as MacDonalds, Evans or Britannia compared more than favourably with foreign designs.

The fettling shop was referred to as having an insufficiency of attention devoted to it, probably on account of its being a non-productive department. It should be amply supplied with the latest types of machinery. A definite arrangement should be made to have the castings which require passing inspected during a certain period each month.

Sands for Steel Castings.—This is one of the most important items in a foundry. Common practice is to take a handful of sand, squeeze it, and on opening the hand, if the sand sets firm, it is suitable. It is not, however, always true, for sometimes sands that bind well are, more often than not, too close in texture, which indicates a large amount of clay—the cause of scabbed moulds. It was at one time difficult to get a steel casting with a smooth surface, but at the present day the solution can be found by choosing a refractory sand as high in silica as possible, together with sufficient alumina to bind it. It should also be as free from oxide, lime and magnesia as possible.

After recommending Professor Boswell's treatise on sands to foundrymen, the lecturer expressed the view that British sands were equal in every respect to French and Belgian. "Yorkshire" sand, a material manufactured from British deposits was specially recommended for castings weighing up to three tons. The system, similar to that in vogue in iron foundries, of repeatedly using the same sand was strongly condemned on the ground that surface and other defects are thereby introduced. French and Belgian sands, let down with about 25 per cent. of silica sand, are very good for green-sand castings, but this type of casting when skin dried by means of a portable lamp and cast in a proper manner with the surface of the mould facing the runner studded with wire nails, much scabbing and many short run castings would be obviated. A similar mixture serves very well for centre cores when washed over with a thin layer of silica paint. British sands, however, can be mixed, which will answer the same purpose equally well.

Some of the illustrations used for the purposes of the lecture are shown in Figs. 1 to 6.

An Alloys Research Association is being formed in the U.S.A. under the auspices of the National Research Council.

Stellite.*

[A recent analysis of stellite showed it to contain Co 59.5, Cr 10.77, Mo 22.5, C 0.87, Si 0.77, Mn 2.04, S 0.084, P 0.04, Fe 3.11.—EDITOR.]

Stellite is made almost entirely in electric furnaces of the Snyder type. The materials composing the alloy are placed in the furnace in the usual manner, and the current turned on. The alloy fuses rapidly without much oxidation, under the intense heat of the arc. It is found that the metals composing the alloy chromium is most readily oxidised, while cobalt seems to show more volatilisation and tungsten is subject to the least change. It is true that the portion of furnace above the metal becomes filled with nearly pure carbon monoxide. This gas will oxidise chromium under certain circumstances at very high temperatures, though apparently no free carbon is produced in the furnace. This is probably because there is sufficient free oxygen or carbon dioxide to re-oxidise any carbon that may be temporarily produced.

At first much difficulty was experienced with the electric furnace linings, but after a certain amount of experiments it was found possible to make a magnesite lining which gives most excellent satisfaction in practice. At first these furnaces gave only eight or ten melts without either complete relining or heavy repairs. Two thousand to three thousand melts from a single lining are now commonly obtained, and some of them stand even longer than this.

The electric arc, on account of its extremely high temperature, causes a certain amount of volatilisation or oxidation in the melting of many metals, but stellite withstands the conditions remarkably well, particularly after the fusion is once made. In melting scrap, however, if certain precautions are observed, only a very slight loss is experienced in remelting. Stellite can be melted in covered crucibles under suitable precautions with a loss of less than 2 per cent., and sometimes it does not even reach 1 per cent.

The hardness of cobalt-chromium alloy can be materially increased by the addition of either tungsten or molybdenum, but either of these metals in any considerable quantity rendered the alloy unworkable either hot or cold. It can, however, be cast into almost any desired form, and when cast bars are ground to a cutting edge and placed in the tool-holder of a lathe the alloy at once shows a considerable advantage over high-speed steel as a lathe tool.

Not only have the stellite alloys containing cobalt, chromium and tungsten, or cobalt, chromium and molybdenum shown great economic advantage as lathe tools, but the binary alloys (consisting of cobalt and chromium only) have likewise received a wide application in the form of dental instruments, surgical instruments, pocket knives, etc.

A modified stellite alloy known as Festel metal, consisting of cobalt, iron, and chromium, is also manufactured into table knives, which give excellent results in service.

All of the above alloys are practically immune to all atmospheric conditions, whether the air be moist or dry or whether it contain minute quantities of sodium chloride or sulphuretted hydrogen. Knives made of this alloy can be used for cutting all sorts of fruit, without becoming discoloured in the slightest degree. A new and interesting application of malleable stellite is as a substitute for gold in the manufacture of pen points for fountain pens. The tips of these pens may, if desired, be made of extremely hard stellite, which can be welded to the malleable alloy. This application is particularly gratifying because the metals replaced, gold and iridosmium, are exceedingly expensive.

SAND BLASTING CASTINGS.—According to A. W. Gregg, Whiting Foundry Equipment Company, Harvey, Ill., in a paper, "Cleaning Castings in a Steel Foundry," presented at the recent annual meeting of the American Foundrymen's Association at Columbus, Ohio. The sand-blast equipment should be carefully selected to conform to the class of work. Great improvements have been made in sand-blasting machinery in the last few years, and the foundry now has a selection of several different types adapted for light or heavy work. All modern sand-blast rooms have an exhaust system which changes the air four to five times per minute. The sand falls through the grating in the floor, is automatically elevated, screened and returned to the pressure tank. It is important to secure the proper quality of sand, and attention should be given to the use of the proper sized nozzle. Compressed air is expensive, and its consumption should be carefully watched.

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* Extract from a Paper read before the American Electro-Chemical Society, by Edward Haynes.

What is Semi-Steel?*

By H. Field.

The lecturer said, at the outset, that his experience with this mixture has been entirely for castings not over 1 cwt. in weight, but this may not affect some of the notes and conclusions.

Methods of Manufacture.—Semi-steel may be made by two distinct methods, and its properties and usefulness will vary somewhat accordingly. The first and simplest method that suggests itself is to add steel to a ladle of molten cast iron, mix the two, and cast the mixture, and this is no doubt true semi-steel. The steel must of necessity bring down the total carbon contents of the iron to a figure more like the carbon contents of steel. If molten steel be available the method is excellent, but as this is rarely the case the addition of solid steel, even if preheated, is not to be commended. The addition of solid metal to already liquid metal is bad practice, is not dependable, and must give inconsistent results. Ironfounders often follow this line in order to cool their metal quickly, but it seems altogether wrong to spend time and money on planning a mixture and melting it correctly, and then to alter and adulterate it by the addition of scrap and a liberal supply of sand adhering to it. How can good, clean castings be expected? The practice may be permitted with a ten-ton ladle of iron, but not with one containing only a few cwts. and often only a few pounds. A waste casting often results, but the cause is hidden from the man who is seeking it, for he is ignorant of the way the metal has been altered by this addition of solid scrap. But besides being wrong basically, the addition of solid steel scrap must, of course, lower the temperature of the metal, and so lessen its usefulness. With molten metal at 1,400 deg. C. the addition of 10 per cent. solid scrap will bring its temperature down to 1,250 deg. C., or thereabouts, a very different matter from its initial temperature. This alone limits the application of the method to low steel percentage. Again, every foundryman does not know that in order to melt the steel it is necessary to bring it to its melting point, and also to supply "latent heat" which is required to convert a solid at its melting point into a liquid at the same temperature.

With steel, the temperature of the mixture will be actually less than the average of the iron and steel used, calculated proportionally. Still another cause which makes the mixture less fluid, although not lower in temperature, is the decrease in total carbon. Obviously, these causes rob the metal of available heat and fluidity, and therefore detract from its usefulness, for nothing is more important than a high casting-temperature.

The properties of this type of semi-steel, show reduced total carbon gives added strength, but the same factor also contributes to increased hardness as the proportion of combined-carbon to graphite is higher in low-carbon iron than high-carbon iron, other elements being constant. It will be seen that the amount of steel which can be added if the metal is not to be spoiled, is too small to exert any large influence on the properties of the new metal.

There is one way, however, in which such metal could be made in bulk, and that is in the air furnace, where steel, either solid or liquid, might be added in almost any desired proportion to already molten iron without a raising of the total carbon content above the average of the two metals mixed. This method should give the best semi-steel, but it is not in use to any extent.

The cupola, the commonest form of furnace for melting iron, does not lend itself to the production of an exactly similar metal. Here the steel even more completely loses its identity and the name "semi-steel" becomes even less applicable. In this method the pig iron and steel are melted together in each charge; no special form of cupola is necessary, but a number of points call for attention if the best results are to be obtained.

Order of Charging.—Each charge will generally be made up of three parts, pig-iron, steel and scrap, either grey iron or semi-steel. The steel may therefore be put in one of three places, first after the coke charge, second between the pig and scrap, and third after the scrap on the underside of the following coke charge. It is necessary that the steel be in contact with coke, and therefore the second place may be ruled out. Some may say that steel will be harder to melt than pig-iron, and therefore should be put in the position which the pig usually occupies, first above the coke. The best place is, however, last in the charge for the steel will in fact melt just as readily as the pig-iron, and under like conditions will probably melt faster, for it will be thinner in section. The best results from the point of view of regular mixing, have been obtained when charging steel last.

Character of Steel Scrap.—This is one of the most important factors in the successful melting of semi-steel. Various forms of steel scrap are available as waste from manufacturing processes, but all forms are not suitable for this work. Steel borings or turnings should be avoided, unless bulked in some form, just as much as iron turnings would be. Punchings under 1 in. in diameter and thin sheet steel from the press shop should also be classed as unsuitable. The most useful scrap usually available is that from motor-chassis work, consisting of small pieces of channel, angle and T sections, 3 or 4 ins. long, or small plate scrap 3 or 4 or even 6 ins. in diameter, and $\frac{1}{4}$ in. to $\frac{1}{2}$ in. thick. Surface area is the governing factor, both for good and evil. The steel only melts by virtue of its surface being in contact with fuel, but we have also to consider oxidation through exposure to blast. Very small stuff is to be condemned for two reasons; firstly that it falls rapidly down the cupola and so assumes a wrong place in the charge, making some parts too rich in steel and others too poor; secondly, that in this hasty descent the steel may not be sufficiently carbonised to melt, and may be found in the casting in the form of hard spots. Thin sheet steel, being free from this liability, might be thought to be very suitable, but this is not the case for the steel in its descent is subject to oxidation.

There may be two reasons for this, the greater purity of steel as compared with iron, and also the fact that steel is not protected by sand, as are pig-iron and scrap. Certainly steel tends to oxidise faster in the cupola than do the other constituents of the charge. If this oxide gets into the metal it can only be deleterious, although the exact effects of iron-oxide in cast-iron are not well established.

If the steel oxidises, it ceases to function in the mixture as steel, and the oxide probably passes entirely into the slag. Referring to Table I., it can be safely stated that slag from semi-steel melting is always richer in iron than that from normal grey-iron mixtures under the same conditions. It has been stated that in certain cases where the steel suffers excessive oxidation, the slag may contain 35 per cent. to 40 per cent. of ferrous oxide, and may then be almost a foam and come up over the tuyers.

Table I.—*Showing the increase of iron in cupola slags varies with the type of steel scrap used.*

Ferrous iron content of slags.	Per cent.
Ordinary grey iron	2 to 4
Semi-steel, ordinary practice	5 to 8
„ thin steel	10 to 12
„ thin steel, rusty	20

One other form of steel must be mentioned, *i.e.*, high-carbon steel scrap, such as files, chisels, etc. No objection can be made to these, as their higher carbon-content makes it more likely that they will be carbonised to the same extent as the pig-iron, and so tend to the uniformity of the charge when melted.

Unless it be on the first charge, $\frac{1}{2}$ in. is the maximum section of the steel to be used.

The Pig-iron Used.—There is very little advantage to be gained by the use of so-called "High-class irons" in making semi-steel. The results obtained from mixtures of steel with the cheapest

* Lecture read before the Birmingham Branch of the Institute of British Foundrymen.

XUM

irons on the market have been so nearly equal to those with more expensive irons that the use of these has been almost discontinued. The most suitable iron seems to be an open-grained one, and, in this respect certainly, some of the Scotch brands hardly seem to have an equal. The transverse strength is a little higher when the better irons, with their lower phosphorus, are used, but not sufficiently so as to warrant their inclusion.

Blast.—Probably this is the most important factor in semi-steel melting. The cupola should have an ample tuyer area of at least one-fourth or one-fifth of the furnace area at the tuyers; and a number of tuyers are better than a few giving the same total area. The blast pressure in the belt should never exceed 7 or 8 ozs. per square inch, so as to avoid a strong oxidising tendency, but the volume of air should be ample, and of the order of 30,000 cub. ft. per ton of iron charged. These factors can be regulated by blast-meters such as those made by the Bristol Company.

Mechanism of Melting.—Cupola temperatures as a general rule are not high enough to melt mild-steel as such, and it is only after chemical change has taken place that the steel melts. The steel, in its descent of the cupola, is in contact with hot carbon, i.e., coke and carbonaceous gases, from which it absorbs carbon. This absorption may go on until the carbon reaches 4.3 per cent., when it becomes saturated, so that as pig-iron usually contains from 3¼ to 3¾ per cent. of carbon, it is possible, but not probable, that even the pig-iron in its descent of the cupola may take up more carbon. As the carbon absorbed increases in amount the steel becomes medium hard steel, high carbon steel and then cast iron, the melting point varying inversely with the carbon content. How much carbon the steel takes up before it melts depends on the temperature at the particular place where it is, and the time it stays there. The steel in the first charge will be under better conditions for absorption than that in other charges, and before it melts will probably have reached a level in this respect equal to the pig-iron. But the steel in other charges will be under different conditions and whilst it is fairly possible to ascertain in what part of the cupola the pig-iron melts, the melting zone for the steel is varying and uncertain. Steel, the descent of which has been slow, melts easily, but pieces that have fallen quickly have not had the same opportunity to absorb carbon, and it is quite likely that some would pass through the melting zone without melting, and would melt afterwards in the bed, by virtue of being surrounded by molten metal. The outer surface of any given piece of steel will always contain more carbon than the inner portions, hence at the melting-point corresponding to the carbon on the surface this portion will fall away and expose a fresh portion to the maximum carbonising influences, to be raised in due course to that necessary for melting. Hence the rate of descent will influence amount of carbon absorbed. Probably more carbon is absorbed by the molten metal in the bed in contact with the incandescent coke there, but this again is influenced by the time of contact.

Considering the molten constituents of the charge, as they lie on the cupola bottom, it must be understood that there may be, and almost certainly will be, a wide divergence in composition throughout the whole. The ironfounder wishing to obtain best results would not consider the mixing of white and silvery-irons in order to obtain a good foundry grade—the risks would be too great. It should be an axiom of good melting-practice that widely different irons should never be mixed together.

The cupola is not a metal mixer, for the coke-bed will hinder or entirely prevent the free movement of molten metal so as to give uniformity. There is no chance for actual mixture until the metal is in the ladle. In the case of semi-steel melting, widely different materials are used, and they are still very different after melting for the one-time steel is now a white cast-iron, very low in silicon, sulphur and phosphorus. Therefore, precaution must be taken to mix the iron. In the case of large castings, the very necessity of the case demands that a large ladle should be used, and with the continual disturbance caused by the flow of metal into it, the mixing should be adequate. With light work, the iron is often caught direct in a hand-ladle holding a few pounds, or at most only a small proportion of the charge, and from this is cast direct into the boxes. This practice is not desirable with any class of iron, but it is folly with semi-steel, as there is being melted together white and grey irons, 2 per cent. silicon and nil silicon, 1 per cent. or more phosphorus and 0.06 per cent. phosphorus. The precautionary measure to be taken is to have the iron run from cupola to a receiver or to a large ladle which will serve the same purpose. This receiver should hold if possible something like the weight of a charge. Generally, this can be done, as the furnace melting for small work will not as a rule be of a size too large for a charge of 6—8 cwt. A large shank mounted on trestles immediately beneath the cupola spout, serves the purpose admirably, and it can be easily tilted for filling hand ladles.

Using such a method, uniform results can be obtained as can be shown by taking a sample from each shankful in a 10 or 12 charge blow and having the samples analysed. Silicon and phosphorus which are the two elements differing mostly in the steel and iron, will now be constant.

Casting Temperature.—The casting temperature, to obtain the best results from semi-steel, should be the very hottest that the particular mould in question will permit.

The Properties and Composition of Semi-Steel.—Mr. McLain, the American semi-steel expert, says that there is no true semi-steel with less than 25 per cent. steel; but if this means that less than 25 per cent. steel does not influence the character of cast-iron, then the author feels himself absolutely at variance with this gentleman. It has not, in fact, been found necessary to advance beyond this percentage to obtain the results which will be outlined. Five per cent. of steel mixed with a soft grey iron will produce a considerable closening of the grain; 10 per cent. has a remarkable effect compared with the addition of a 10 per cent. of any so-called "strong-iron," whilst for light work the maximum of advantage is obtained with a 20 per cent. steel mixture. The addition of more steel does further improve the quality of the final product, but the difficulties of melting and the risks to be taken are much greater with these higher percentages. In motor cylinder work, for instance, American practice is to use 40 per cent. or 50 per cent. steel, but the author frankly states that he has made 20 per cent. semi-steel, on which for closeness of grain, and absence of porosity, it is impossible to improve. High steel-mixtures are usually remelted, which process is, in my opinion, to its detriment, as the sulphur cannot fail to be increased. On this matter it should be explained that by a 10 per cent. steel mixture is meant 1 cwt. of steel to 9 cwt. of pig and scrap, irrespective of the scrap being normal grey-iron or semi-steel. The question arises as to whether semi-steel scrap should be calculated as carrying steel into the mixture, but the author never allowed for this, and always put new steel in up to the percentage which the mixture is supposed to be. Briefly, the addition of 10 per cent. steel to an open grained, common foundry-iron, such as a mixture of No. 3 South Staffs., Northants. or Derbyshire pig will raise the tensile strength from 10 or 11 tons to 16 tons per sq. in. and 20 per cent. steel will bring it up to 20 tons. Without wishing to raise any controversy, the author feels bound to differ from Mr. J. E. Hurst, who, in a Paper to the Institute in 1915, says "that cupola melted semi-steel must be considered a failure when considered from the standpoint of those people who urge wonderful results from this product." The figures given above are those obtained in every-day practice with semi-steel melted in a cupola under the conditions outlined in the first part of this Paper. Granted that 17 or 18 tons can be obtained at times from a normal pig-iron mixture without steel, such results are not common, and the conditions under which they can be obtained are but imperfectly understood, and not so fully under control as to allow of their being guaranteed. For such work, expensive cold-blast, refined or otherwise special-irons, must be bought, at a price always excessive, but nowadays prohibitive, and to obtain these results not 10 per cent. or 20 per cent. must be used as in the case of steel, but 100 per cent. is required. Therefore, on the ground of expense alone, semi-steel cannot be ignored, as expensive pig-irons are not required

for its manufacture, and steel-scrap can now be bought more cheaply than any pig-iron on the market. Undoubtedly, the product of semi-steel stands out as one of the most important landmarks in the whole field of materials of engineering.

In Table 2 is given an outline of the chemical and physical tests obtained in regular working.

TABLE II.—*Chemical and Physical Tests of Semi-Steel.*

	10% Steel.	20% Steel
Silicon	2.0	1.8
Sulphur	0.110	0.125
Phosphorus	1.0	0.85
Manganese	0.60	0.70
Total Carbon	3.25	3.40
Combd. Carbon	0.35	0.50
Tensile	16-17 tons	19-20 tons.
Transverse	3,300 lbs.	3,800 lbs
Elongation and reduction of Area	Nil	Nil
Tensile Bars	Cast ¾ in. diameter.	Machined to 0.564 in. diam.
Transverse Bars	12 in. x 1 in. x 1 in.	

The effect of casting temperatures on these strengths cannot easily be over-estimated. The same metal which gives 19 to 20 tons tensile when cast as hot as possible will only give 12 tons or even less if cast cold. There may be, in fact, a drop of 2 or 3 tons very easily in this manner, of course the 12 tons being from very cold metal. With abnormal conditions where everything else has been correctly done, only 8 tons is sometimes registered. It is therefore good practice to get the iron from the cupola to the mould as quickly as possible.

In regard to the analyses quoted, the manganese might with benefit be somewhat higher, but as is well-known, there are only a few pig-irons available with high manganese content. It will be noticed that the total carbon is just as high in this steel-iron mixture as in the pig-iron itself, showing the extent of absorption of carbon by the steel in its descent of the cupola. It will also be noticed that the total carbon of the higher steel-mixture is greater than that of the 10 per cent. mixture, which is usually found to be the case. The pigs in each mixture were similar.

Nomenclature.—Having considered the tensile strength of semi-steel and found that it is so much higher than that of ordinary cast-iron as to justify the name semi-steel, reference must now be made to another physical property which is an essential of steel, *i.e.*, ductility. It is here the name semi-steel becomes a misnomer, for it never possesses this property to any greater extent than cast-iron itself. Here buyers of semi-steel may easily be misled, especially such as have been using steel and not cast-iron, as semi-steel as a rule will not fill the place of steel, or do similar duty. Probably it would be an advantage were the name dropped, and with it all pretence of steel-like properties.

Ductility.—Obviously there would be a tremendous field of service for any direct cast-metal possessing ductility. The one great disadvantage of cast-iron is its brittleness and absolute lack of ductility, and if a real semi-steel could be produced which could be cast as readily and with as much fluidity as cast-iron, and yet possess even a fraction of the ductility of steel which is not so readily melted or cast, then the use of such a metal would be almost unlimited. There are numerous cases in engineering in which a large measure of ductility is not required. For instance, exhaust pipes for a well-known motor-car were made in semi-steel; these had to be bolted down in six places, and the face being not quite true, some pressure was applied at one bolt, the others being all tight. The material of course would not bend to the pressure, and the casting cracked. A very small measure of ductility would have met the case. This ideal material has, however, so far evaded the grasp of the foundry worker, but such a problem might be presented for investigation by the newly-formed Research Association.

To obtain exact information, a number of test-bars were sent to the National Physical Laboratory, but the report returned was, "There was no yield load, extension, or reduction of area at fracture."

Through the kindness of Mr. Charles Retallack, who visited the American Foundrymen's Convention in October, 1920, the author had the opportunity of putting the same questions direct to Mr. McLain. It was no great surprise that Mr. McLain answered, "We have no hope of producing a malleable semi-steel direct from the cupola, open hearth or electric furnace. I agree with you that if we could produce such a material it would prove of exceeding value to the trade."

Hardness.—Hardness, as measured by machineability, is a property more essential than either strength or ductility if semi-steel is to be a successful material. Without this qualification it cannot hope to stand, especially for light castings, where so much machining is done compared with the value of the article as a casting. The hardness of well-melted semi-steel is about 230 Brinell, or may be interpreted in terms of combined-carbon as in Table 2. Here it will be seen that the combined carbon is not excessive, and should not prevent any ordinary machining operation, even on light work, although it will certainly be found somewhat tougher. This property of machineability will be found to be influenced partly by composition, but more largely by the relation of blast-pressure and volume.

Light semi-steel castings are rather subject to hard spots. These are not unknown even with the softest grey-iron mixtures, and are more common in low silicon mixtures. Their importance cannot be overlooked, or, indeed, be exaggerated, since they are probably more harmful to the machinist than would be a generally hard material, owing to the severe blow given to the fast-moving tool. Their causes are several in number; high sulphur in the mixture, especially in the first charge, which has stood in contact with the bed-coke; improper mixing of the several portions of the charge; and, lastly, disregard of the great liability of semi-steel to chill. This trouble occurs more often where small heats are being blown, or where insufficient ladles are at liberty to dispose of the metal rapidly when tapped.

Annealing.—Recognising the possibilities of such troubles occurring, the author has investigated the influence of annealing semi-steel. A short account of the influence of annealing on grey-iron may be of interest, although not within the title or scope of this Paper. As is known, large quantities of grey-iron 18-pounder sockets were made during the war, the specification being 10 tons tensile after annealing. The general consensus of opinion on annealing certainly led me to expect such a reduction that an iron giving 10 or 11 tons as cast would not pass the test when annealed. On actual experiment, however, it was found that ¾ in. test-bars of this common grey-iron, when annealed for one hour at 750 deg.—800 deg. C. were raised at least one ton in tensile. The author is not aware if this is a well-known fact, but its reliability is beyond question, as over 200 heats of this metal were poured and annealed, and the test-bars broken side by side with similar bars cast in the same manner, but not annealed. Of these 200 annealed bars, 90 per cent. showed a well-marked increase, none failed to pass the 10-ton test, and the average was for unannealed bars 10.8 tons; for annealed bars, 11.7 tons. The one-hour period was amply sufficient to soften the casting and open the grain, but the tensile strength was, nevertheless, decidedly increased. A more prolonged annealing produced such a fall in tensile as other observers have recorded.

TABLE III.—*Tensile Tests on Heat-treated Semi-Steel.*

	10 per cent. semi-steel.	20 per cent. semi-steel.
As cast	17.5	19.0
½ hour at 800°C.	18.0	18.9
1 hour at 800°C.	15.5	15.6
2 hours at 800°C.	14.5	14.6

Semi-steel was therefore investigated on similar lines to discover how far a casting could be softened without a decrease in strength. As they were fairly light castings, such as automobile cylinders, air-cooled or water-cooled, it will be understood that a half-hour annealing at 800 deg. C. would often be sufficient to remove a hard skin or chilled corner. A ½-in. test-bar is a fair strength

to compare with such castings, as they rarely have greater sections than this, and the grain of such a bar is altered right to the core in half an hour. Table 3 shows results from actual practice.

From these results it will be seen that short annealings can be safely given without injury, although owing to the opening of the grain such a process is not advisable where avoidable, but the application of this treatment, when its effect is clearly understood, will often save an expensive casting from the scrap heap. Hard spots, unfortunately, do not as a rule lend themselves to elimination in such a short time.

Theoretical Considerations. It has been shown that the steel must become carbonised in its descent of the cupola, in order to melt, and it is therefore impossible to consider semi-steel as an alloy of iron and steel, for the steel has lost its identity as such before it joins the molten mixture. It has further been mentioned that the carbonised steel, when fully carbonised, somewhat resembles a very pure white cast-iron or "washed" iron, but semi-steel is superior to a mixture of white and grey cast-iron. The theory often put forward that the gain in strength shown by iron when 10 per cent. of steel is added is due to the reduction of phosphorus and silicon by 10 per cent. is obviously unsatisfactory, since such a reduction in these elements often produces no effect at all on physical properties, or at the most only a slight effect. Chemical analysis does not reveal wherein the strength lies, for a semi-steel casting can be definitely selected or recognised by its analysis. The microscope, however, leads to the conclusion that the carbon which is absorbed in the cupola by the steel is of a much finer variety than that met with in ordinary iron, this fact being clearly demonstrated by the examination of strong semi-steel specimens. Whilst this is but theory, yet the graphite certainly is much finer. The phosphorus is found generally in the well-known network form, but this alone cannot explain the results obtained.

Conclusion.—What then are the possibilities of a malleable semi-steel? Malleable castings of the ordinary kind are often almost as high in silicon and phosphorus as much semi-steel, and certainly much higher in sulphur. The ductility of the malleable casting is largely due to ferrite grains and a fine variety of precipitated graphite. If the whole of the graphite in semi-steel could be obtained in the fine form (only a portion is already found), would this lead to a malleable product? If so, is there any method of obtaining all the graphite in this form except by the use of 100 per cent. steel?

In conclusion, the author thanked Messrs. John Harper & Company, Limited, Willenhall, Staffs., for free permission to include any facts or figures which have occurred in practice at their works.

A Charging Apparatus for Annealing Ovens.

A recent issue of "The Iron Age" gives an important application of the electric storage battery truck in industrial plants, which has been made by the Elwell Parker Electric Company, Cleveland. This company has brought out a new type of truck for charging annealing ovens in malleable iron foundries. Amongst the advantages claimed are that it will serve the entire annealing department and oven floor space, and can be run by an inexperienced operator.

The truck has three wheels, one for steering and two for driving, and at its front is provided with an electrically-operated annealing-pot lifting-device. The steering wheel is turned by an automobile type wheel mounted on the top of a vertical steering mast turning on ball bearings. The steered wheel is carried in a spring cradle so that the shock is cushioned when running over an obstruction. The wheels are equipped with rubber tyres if the truck is to be used with ovens charged at low temperatures, or with a smooth steel wheel on the steering end and a pair of herringbone steel driving wheels on the drive end for use with ovens having high charging temperatures.

The operator stands on two pedals, one of which controls the brake. When this pedal is pushed down by the operator's left foot the brake is off. When the right pedal is depressed the circuit breaker closes, but only when the controller is in off position, connecting the controller to the battery carried in a compartment on the truck frame. The operator must stand on the truck to operate it, for if he steps off it stops automatically.

To operate the pot lifting device a switch is closed, the forks move close to the floor, the truck is driven forward, and the forks inserted beneath the pot stool. Upon closing the switch the stool and pot are lifted 6 in., a trap stopping the lifting mechanism when a predetermined height is reached.

The lifting mechanism consists of a series wound motor, which receives its power from the same battery as the propelling motor. This motor is equipped with a special brake and directly connected to a worm gear which drives a worm wheel mounted on the clutch spider. The centre of the clutch, which is set for 25 per cent. overload, is a nut through which works a multi-thread worm or ram. This ram is attached to a toggle lifting mechanism which raises or lowers the forks, depending upon the direction of motor rotation. Another safety feature is that the movement of the forks up or down may be stopped at any point by manually opening a switch so that the pots may not be upset if improperly picked up or placed. The lifting mechanism is enclosed, and its working parts run at slow speed in oil.

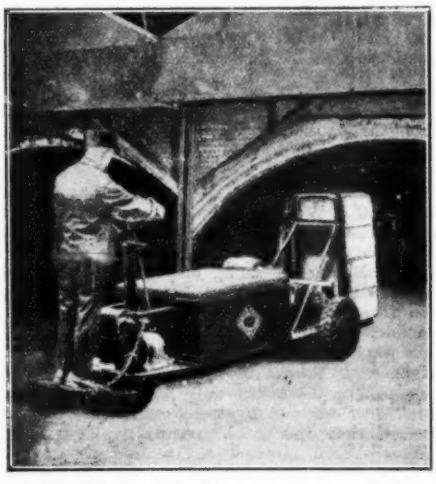

Fig. 1.—Showing the Charging of an Annealing Oven with an Electrically-Operated Truck.

The truck is driven by an enclosed motor direct connected to a worm gear which drives through a four bevel pinion differential to the wheels. The axle is of the full floating type. No weight is carried on the drive shafts. The wheels carry 7½-in. double row ball bearings. There is a contracting type brake between the motor and differential. The whole equipment is assembled on a heavy riveted steel frame. The overall length of the truck is 12 ft., and weight complete with battery, 32 cwt.

The battery is charged at night, and the truck is ready for use in the morning. It is stated that with a single charge of the battery the truck will make 150 to 200 journeys, each journey including picking up, backing out, turning, travelling, setting down, and picking up another 35 cwt. pot and placing it in the next oven.

INSTITUTE OF METALS.—Many interesting features are embodied in the spring programme of the Institute of Metals, whose president is Engineer Vice-Admiral Sir George Goodwin, K.C.B., LL.D. The annual meeting is to be held on March 9, and subsequently various papers will be read, including one by Professor H. C. H. Carpenter, relative to crystallisation. The annual dinner takes place the same evening at the Trocadero, and many distinguished people have accepted invitations to be present. The next morning other papers are to be read. After the annual general meeting, called for May 4, Professor T. Turner, of Birmingham University, will deliver the eleventh May lecture, his subject being "The Casting of Metals." It may be mentioned that the Council have now completed the preliminary arrangements for the printing of a combined "subjects" and "names" index to the first 20 volumes of the journal of the institute. Also that new members can join at the present time under exceptionally advantageous conditions; subscriptions will cover the period ending June 30, 1922, and those elected will be entitled to valuable concessions in the matter of publications.

An order has been made by the Shipping Controller revoking the Shipyards (Licence) Order, 1918. It is therefore no longer necessary to obtain the licence of the Shipping Controller for the repairing, building, etc., of any ship or vessel.

Blowholes, Porosity, and Unsoundness in Aluminium Alloy Castings.

By Robert J. Anderson.

From an insignificant beginning some 20 years ago the aluminium-alloy casting industry, in magnitude, has become one of the more important branches of non-ferrous metallurgy. The technology of aluminium-alloy casting, however, has not developed to a high plane as yet because of the infancy of the industry and more largely because of adherence to traditions and precedents. Some important researches have recently been made by the American Bureau of Mines, particulars of which are now available.

In aluminium-alloy casting practice one of the most serious problems is the prevention in castings of defects that lead to rejection and consequent scrappage Under the general subject of defects, one particular class of defects—namely, blowholes, porosity, and unsoundness—is very serious. From the standpoint of the foundryman, the occurrence of these defects is exasperating, because at times blowholes appear and disappear in a seemingly mysterious manner without the reasons for either conditions being known. It is obvious, however, that it might be considered possible to ascertain the causes of defectiveness and, when these are found, to apply methods of prevention. To attempt to remedy troubles the causes of which are unknown is useless.

Unsoundness in General and the Factors Affecting it.—The urgent demand for a systematic research on the general subject of blowholes, porosity, and unsoundness in aluminium-alloy castings has already been shown. Before taking up an account of the experimental work performed in the present investigation, it is deemed advisable to discuss some of the factors that may influence the occurrence of the defects. It is a somewhat lamentable fact that such a sharp line has been drawn between ferrous and non-ferrous alloys; there is little doubt that the methods which have been so rigorously applied in investigations of steel would have been equally successful for aluminium, bearing in mind, of course, the limitations imposed by the latter. Blowholes in steel have been adequately discussed by a number of writers

Definition of Blowholes, Porosity, and Unsoundness.—Blowholes are regarded as voids within a frozen alloy, filled with air or other entrapped gas, and the entrapped gas is held to be the cause of the blowholes. Blowholes may vary considerably in size, but in aluminium-alloy castings exceedingly large holes are not often found. Small holes, say 0.025 to 0.075 in. in diameter, and pinholes, or microscopic holes, are the rule, rather than otherwise. For example, Fig. 1 shows a macrograph of a microsection cut from an unsound casting of No. 12 alloy (92: 8 Al-Cu); the entire casting was full of holes.

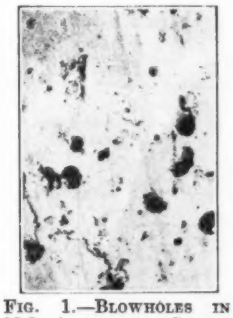

FIG. 1.—BLOWHOLES IN 92.8 ALUMINIUM COPPER ALLOYS.

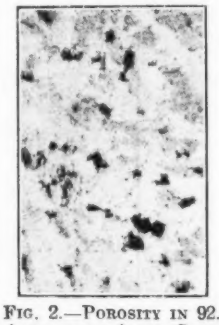

FIG. 2.—POROSITY IN 92.8 ALUMINIUM ALLOY SHOWING SURFACE IN THE OPEN GASOLINE TEST. ETCHED WITH NaOH.

Porosity is held to be the inability of a casting to withstand pressure, or a casting is said to be porous when it shows sespage under the open test with methylene-blue and gasoline. Porosity may be due to blowholes, cracks, or occluded foreign matter, or any two of these, or all three. In foundry practice, a casting with small macroscopic pinholes is held to be porous, and while this may often be the case, surface sand holes are at times confused with deep-seated blowholes, and the former would have nothing to do with porosity. Fig. 2 shows a macrograph of a section cut from a casting showing porosity as indicated by the open gasoline test; the alloy was approximately No. 12 in composition.

Unsoundness is doubtless an undesirable term because of its vagueness; it is used indiscriminately to include blowholes and porosity, and to describe conditions where there may be much foreign non-metallic occluded matter present, and the like. With these ideas in mind, inquiry will now be made into the cause for such defects.

Description of Experiments.—The most common alloy used in the United States for the production of light castings is that one known in the trade as No. 12 alloy—that is, 92 per cent. aluminium and 8 per cent. copper. This alloy, or others of a similar composition, is employed for a wide variety of castings. Hence, in the experimental tests made in connection with the present work it was considered advisable to use this alloy. In the tests about to be described, confirmatory evidence of already known facts has been obtained, and some new data have been made available. The effect of pouring temperature and length of time of melting period on soundness has been studied. The present work did not go into the influence of various furnace atmospheres on the soundness of castings, but that is a matter which merits consideration, and which seemingly has been given entirely too little attention.

In the tests made in connection with the present work, small heats of about 25 lbs. each of the No. 12 alloy were made up. The heats were charged as follows:—The requisite amount of 50: 50 aluminium-copper rich alloy was first melted down in a plumbago-clay crucible, using a gas-fired melting furnace; when the rich alloy had melted, enough virgin aluminium ingot, in the form of 3-lb. six-notch bars, together with about 10 per cent. of No. 12 gates and risers, were added to make up the heat. Six sets of castings were poured, and the essential information is summarised in Table I.

TABLE I.—*Data on Six Heats Made on Aluminium Alloy to Determine Temperature Effects.*

Heat.*	Treatment.	Pouring temperature, °C.	Remarks applying to appearance of castings.†
A ..	Charge heated to 650° C. and poured at once.	650	White, good, smooth appearance.
B ..	Charge heated rapidly to 860° C. and poured at once.	850	Tinted with oxidation stains; rough appearance; many surface holes.
C ..	Charge heated rapidly to 880° C; removed from furnace and cooled to 630° C.	630	White, fair appearance; cold shut.
D ..	Charge heated to 650° C. and held in the furnace for one hour at 650–720° C.	640	White, fair appearance; cold shut not so marked as in C.
E ..	Charge heated rapidly to 900° C. and held in the furnace for one hour at 900–950° C.	950	Oxidation stains; bad looking casting, rough; many surface holes.
F ..	Charge heated rapidly to 900° C.; held in the furnace for one hour at 900–950° C.; removed from furnace and cooled to 700° C.	700	White, fairly good surface appearance.

* Duplicate runs of 25-lb. charges were heated in a gas-fired furnace.

† Average chemical composition was copper 7.62 per cent. iron 0.9 per cent., silicon 0.26 per cent, and aluminium (by difference) 91.73 per cent.

The castings were simply thin shells as shown in Fig. 3, the dimensions being roughly 7.625 × 6 × 4.125 in. and 0.125 in. thick. The cut-out portion, shown in the photograph, is simply a place where a section was removed for microscopy. Two kinds of castings were poured from the first six heats—(1) the thin shells, and (2) bars 0.75 in. sq. by 12 in. long. The shells are hereafter referred to as castings and the bars as bars for the sake of clearness in distinction. Castings of different thicknesses were thus poured for the purpose of ascertaining whether any exaggeration of defects might be traced to size of section under otherwise identical conditions. The castings and bars were poured in ordinary sand moulds, properly rammed and vented; each casting was poured in a single mould and its companion bar in a separate mould. In the first six heats the influence of pouring temperature and length of time of melting on soundness was observed. Duplicate runs, in which the data were essentially as already shown in Table I., were also made for checking purposes. A composite sample of the first set of six castings and bars averaged 7.62 per cent. copper, 0.39 per cent. iron, 0.29 per cent. silicon, and 91.73 per cent. aluminium (by difference).

Table I. shows that heat A was kept at as low a temperature as possible, compatible with fairly rapid melting, and as soon as the charge was totally in solution the castings and bars were poured. The total time in the furnace necessary for solution was approximately 30 minutes for all the heats, starting with a hot furnace

and hot crucible. The castings poured from heat A were regarded as good, moderately sound, and of satisfactory surface appearance. Sand holes were few.

In heat B, the charge was rapidly brought to 860 deg. C., and the castings and bars were then poured. The total time in the furnace was about 40 minutes. The resultant castings from this heat were extremely poor; the surfaces were rough, with many sand holes, and the castings were dark coloured.

In heat C, the charge was heated rapidly to 880 deg. C., the total time in the furnace being about 40 minutes; the crucible was then removed and permitted to cool in the air to 630 deg. C., at which temperature the castings and bars were poured. On account of the low pouring temperature, the shells were cold shut but other than that their surface appearance was satisfactory; there were few sand holes.

Heat D was in the furnace one hour and 30 minutes,

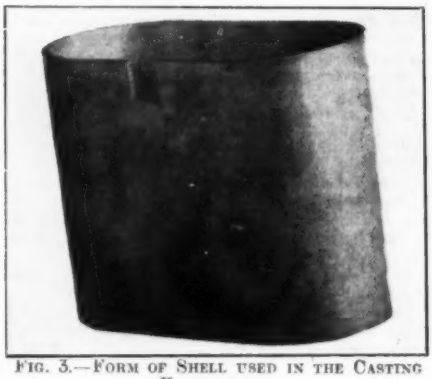

Fig. 3.—Form of Shell used in the Casting Experiments.

heat E one hour and 40 minutes, and heat F one hour and 45 minutes. This was done so as to obtain figures on the effect of the length of time of melting on soundness. Heat D was held in the furnace for an hour after solution was effected; the temperature was kept fairly low, and the castings and bars were finally poured at 640 deg. C. The resultant castings were cold shut, but not so markedly as in heat C, poured at 630 deg. C. The surface appearances of both bars and castings were considered satisfactory; there were only a few surface sand holes. Heat E, poured at 950 deg. C., after being held in the furnace for an hour at 900 deg. to 950 deg. C., gave very poor castings; the surfaces were rough and had many sand holes, and the colour was dark and dirty. Heat F, however, resulted in fairly good castings; this heat was poured at 700 deg. C. after heating for an hour at 900 deg. to 950 deg. C.

Additional tests of the effect of the pouring temperature alone on unsoundness were made by making up 60-

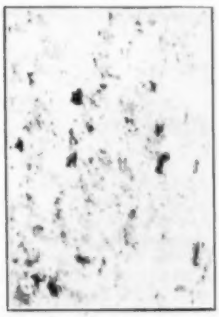

Fig. 4.—Unsoundness in 92.8 Aluminium Copper Alloy Poured at 640 deg. C. Lightly Etched with N3OH Vertical Illumination.

Fig. 5. — Unsoundness and Blowholes in 92.8 Aluminium-Copper Alloy Poured at 950 deg. C. Etched with NaOH Vertical Illumination.

lb. heats of the 92.6 aluminium-copper alloy, in the manner previously described, and pouring bars 1½ in. square by 12 in. long at 50 deg. C. intervals, and showed that soundness, surface appearance, and colour vary with the pouring temperature. Duplicate runs were made for the purpose of checking. In these tests a charge of 60 lbs. was heated rapidly to 975 deg. to 1,000 deg. C.; the crucible was then removed from the furnace, and bars were poured at 50 deg. C. intervals from the same pot by allowing the melt to cool between pours. The range of pouring temperature was from 950 deg. to 650 deg. C. The average composition of a composite sample of the 1½-in. square bars was copper 7.55 per cent., iron 0.36 per cent., silicon 0.29 per cent., and aluminium 91.80 per cent., by difference.

The resultant castings and bars from all the heats, referred to as A to M, inclusive, were examined for surface appearance and microscopically for general characteristics and unsoundness. Polished microsections of both castings and bars were examined microscopically, and machined surfaces were inspected for blowholes. All temperatures in these experiments were taken with a base-metal thermocouple of the pyod type.

Metallography of Unsoundness.—The castings and bars were examined macroscopically and microscopically for blowholes, porosity, and general unsoundness. In

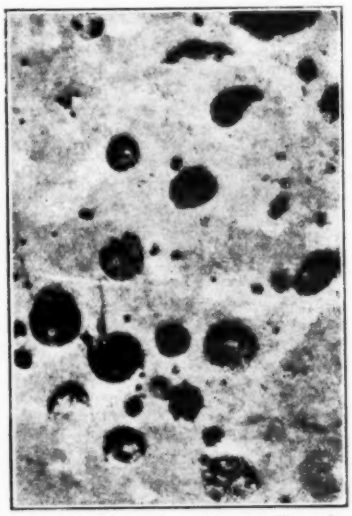

Fig. 6.—Blowhole in a Sample Taken from a Crank Case (x 5).

examining castings for relative unsoundness, this defect can be judged most conveniently by simply inspecting polished or machined surfaces. Microscopic examination is not so useful. In the present experiments the bars cast from the various heats were machined smoothly by milling, and the surfaces were inspected for holes. Microsections from the bars and castings were also prepared and studied. As indicative of what a macrograph can show as regards relative soundness, reference may be made to Figs. 4 and 5. The former shows the surface appearance of a microsection cut from a 0.75-in. square bar cast from heat D, poured at

Fig. 7.—Internal Hole Shown on Fracture in a Sample Removed from a Crank Case (Actual Size).

640 deg. C.; the latter is a similar macrograph from heat E, poured at 950 deg. C. Machined surfaces also show relative unsoundness and blowholes fairly satisfactorily.

The microscopic examination of sections cut from the various bars and castings served to throw some light on the question. Evidence of at least three kinds of unsoundness was obtained from the microscopic study, as follows:—(1) That which is plainly intergranular and may be due to an actual forcing apart of the grains by gas attempting to escape or due to intergranular occluded foreign matter; (2) that due to libera-

tion of gas which is entrapped at the moment of final freezing and cannot escape, resulting in blowholes of varying size; (3) that which is the result of balled-up oxide occluded indiscriminately in rather large gobs in the frozen alloy.

Miscellaneous Considerations.—Although this report makes no attempt to deal with the subjects of cracks in castings, it may be said that the origin of cracks is often confused. Cracking in an aluminium-alloy casting is customarily regarded as resulting from direct fracture of the metal by reason of contraction in volume on passing from the liquid to the solid state. Considerable variation in size of contiguous sections augments the tendency to cracking. That some surface cracks are intimately associated with deep-seated internal blowholes has been shown by fracture studies In a number of sections it was found that the surface cracks penetrated into an interior blowhole of rather large size, say 0.25-in. dia., and that the blowhole caused the cracks. The examination of surface cracks in aircraft motor castings and inspection of polished microsections from the same castings indicate that blowholes may be associated with surface cracks and may even be the direct cause of them. A rather badly cracked crank-case, made of the 92:8 aluminium-copper alloy, may be cited in support of this view. Fig. 6 shows the microstructure of a section cut from this particular casting from a portion which was badly cracked as to surface. In examining fractures of the same casting, internal blowholes (see point X, Fig. 7) were found from which cracks led to the surface.

It might be inferred from what has gone before that the writer believes perfectly sound castings can be made at all times. No such inference should be drawn. Evidently, however, many castings are needlessly unsound. For certain castings, where neither strength, soundness, nor good surface appearance are desired, there will be no object in making strenuous efforts to guard carefully the quality of the product.

The effect of pouring temperature on contraction of the 92:8 aluminium-copper alloy, as previously mentioned, is aptly illustrated in Fig. 8. This shows the heads of the pouring gates of the series of bars cast at 50 deg. C. interval, in heats G to M, inclusive. The amount of contraction is a function of the pouring temperature, so far as the limitations of the experiments can show, but whether it is also, at the same time, connected with dissolved gases is not certain. It is a fact, however, that a casting poured at 950 deg. C. contains more dissolved gases at the moment of pouring than one poured at 650 deg. C.

Gate G, in Fig. 8, was poured at 950 deg. C., gate M at 650 deg. C., and the others at 50 deg. C. intervals. Gate G actually expanded in the head, while the shrinkage of gate M is marked and apparently normal. Graduation in the amount of expansion and contraction are shown in the other gates depending upon the pouring temperature. Gate J, poured at 800 deg. C., seemingly did not contract or expand much; gates G, H, and I expanded; gates K, L, and M contracted.

Conclusions.—Broad generalisation of value cannot be drawn from the results of the experimental work, the experience of the various foundries, and the contradictory literature. This much, however, is fairly well settled: That it is possible to recognise the existence of a large number of variables that may conduce to unsoundness and blowholes, that some of these variables patently are much more conducive to unsoundness than others; and that there are possibilities of developing methods for eliminating these defects The main conclusions that can be drawn with confidence from actual observation in the experimental heats may be summarised as follows:—(1) The number of blowholes present is a function of the pouring temperature; the higher the pouring temperature the greater the number of blowholes and the more unsound is the casting. (2) Unsoundness varies with the temperature to which the charge is heated; the higher the temperature in the furnace the more unsound the resultant castings are, irrespective of the pouring temperature. (3) Unsoundness is a function of the length of time of melting; the longer any melt is held in the furnace the more unsound are the castings, irrespective of the temperature of heating and the pouring temperature.

It can be readily seen that the factors affecting the soundness of castings can influence one another either favourably or adversely. Thus, pouring an overheated melt at a lower temperature by allowing the charge to cool prior to pouring will aid in minimising the deleterious effects of overheating. Castings poured at low temperatures are more sound than those poured at high temperatures, but heats held in the furnace for a long time at either high or low temperatures are more unsound than those held for a short time. The most aggravated cases of unsoundness will result from pouring a melt at a high temperature which has previously been excessively overheated and for a long time. There is nothing to lead to the belief that there is a minimum temperature below which it is not safe to go for fear of unsound castings resulting from too low pouring temperature.

The results of the experimental heats and also past foundry experience, together with the general information available, would lead to the conclusion that, with the methods of melting now in vogue, the heats should be kept at a low temperature in the furnace, melting should be as rapid as possible—that is, the charge should be poured as soon as it is melted—and the pouring temperature should be as low as is consistent with the metal filling the mould. These conditions can be attained only by close supervision of melting and pouring, together with a study of the appropriate correlation between the moulding floor and the furnace room. It will be best to have the moulding floor waiting for metal rather than have the furnace room waiting for moulds. Close pyrometric control is also pre-supposed in actual foundry production.

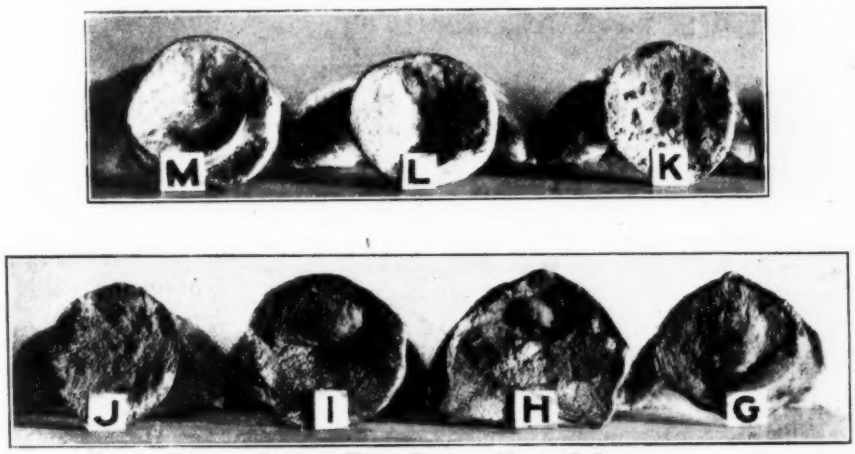

FIG. 8.—POURING GATES ON HEATS CAST AT 50 DEG. C. INTERVALS.

THE INTERNATIONAL EXCHANGES.—The Journal of the Industrial League points out that there is a tendency on the part of many people to urge action in connection with the foreign exchanges, but these people are forgetting that it is not the exchanges which are the disease, but the condition of the exchanges is merely the symptom of the real disease, namely, failure to produce. On the part of this country, the trouble is aggravated in two ways. What we have produced has been produced at such high cost that some of those who wish to buy cannot, and many of those who can buy won't; in other words, the consumers' strike is still in operation. Wholesale prices are falling rapidly, bringing retail prices in their train. The end of the consumers' strike is in sight, and therefore it may be predicted that improvement will begin to show itself at an early date. The rapidity of the improvement will depend on the extent to which employers and employees co-operate to secure cheap production.

OWING to stagnation in the tin industry the last two of the large Cornish tin mines, East Pool and South Crofty, closed last week, throwing 900 men out of work.

The Manufacture of Manganese-Bronze Marine Propellers.—Part II.

By W. Lambert.

Preparation for Moulding.—For the moulding of a solid propeller a circular cast-iron moulding-plate having a thickness of from 2½ in. to 3 in. is first chosen, of a radius about 6 or 7 in. less than that of the pitch-piece to be used with it, and about 4 to 6 in. greater than the radius of the propeller; the plate is then mounted on a permanent foundation called the "bed." By bolting three or four L-irons to the bed, so that the plate fits between them, the replacement of the moulding-plate in exactly the same relative position to the bed is easily accomplished. All moulding-plates are designed so as to be quite rigid when lifted. The accuracy of pitch in a mould is seriously affected by a springing plate.

Into the centre of the moulding-plate is then screwed a steel spindle furnished with (*a*) a strong metal bracket-arm to carry the striking board, (*b*) a strong metal ring or collar fitted with a securing-screw to hold the boss-board, (*c*) a revolving cap, complete with pulley-wheel, cable and balance-weights to support the weight of the striking-board, etc., as shown in Fig. 3. The striking-board is bolted to the arm so that the leading or forward side of the striking-edge is exactly radial so that the remaining blades can be easily marked out.

First Course.—The actual building of the mould follows the usual practice of brick and loam-moulding. The bed-moulds of the blades are built up successively, moving the pitch-piece as required; the bricks should not be closely packed, but left fairly open so that the loam may dry more quickly. The nature of the loam is a very important point. Its behaviour depends largely upon the amount of clay constituent in the sand from which it is made. The loam must be kept as "open" and porous as possible. The blade-moulds are then built and roughly struck up with a loam facing, provision being made both for the runner and the necessary test-bars.

The runner is moulded in loam also, a piece of gas-barrel being used as a pattern. A stock of tubes of varying lengths and diameters, covering a range suitable for the largest to the smallest propeller, is held in the charge of the foundry store-keeper. The runner lies horizontally below one of the blades, opening on the bottom of the boss, while allowing ample room for the core-print; its vertical portion is built up outside the mould,

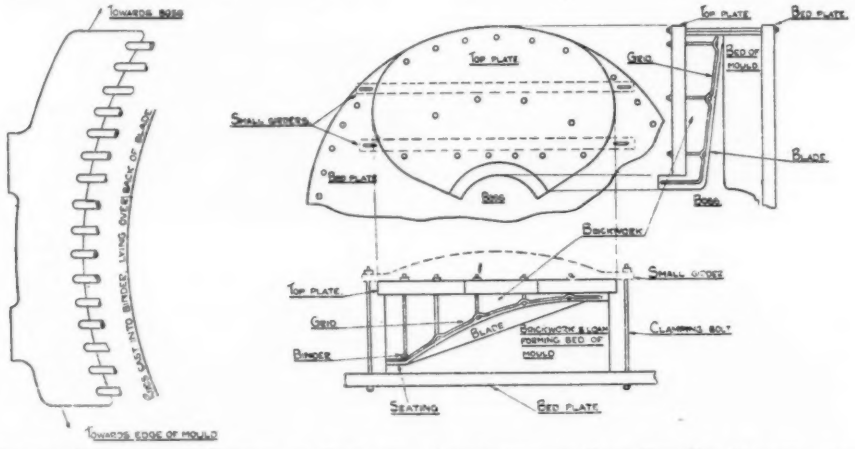

Fig. 3.—Illustrating Binder of Grid and Adjustment of Grid End Top Moulds, also Method of Reinforcement.

to the axis of the spindle. The board is then adjusted with a spirit-level to assure of its being quite horizontal, or at whatever angle the "drop" requires. A suitable iron spike is then screwed point downward to the end of the striking-board, and a circle is traced out on the floor-plate which has been chalked over for the purpose. The circle is carefully divided into three or four parts (according to the number of blades) using a large pair of compasses. The radii extending to these points are plainly marked on the upper surface of the moulding-plate and on its edges, and these indicate the centre lines of the blades. The spike is then removed. The pitch-piece is fitted round the moulding-plate at the known radius, and the roller of the striking-board adjusted to run centrally on the rail, while the centre point of the pitch-piece (distinctly marked in the pattern-shop) is so placed as to meet the extended radius of the centre-line of a blade. The pitch-piece is then clamped or securely weighted to the floor.

A fore-and-aft projection of a blade is now outlined on the plate, round one of the centre-lines. This is done by using strips of wood cut to the half-lengths of sections; these are held from the striking-edge to a set-square placed on the centre-line and marked to the height of the bed-mould; a plumb-line hung from the striking-edge gives the projected outline on the bed-plate. The edges of the mould are allowed 4 to 7 in. around the blade projection, and this final outline is marked with chalk, ample allowance is thereby afforded for the seating of the "cope," *i.e.*, the top portion of a mould, and for the overlapping of wide blades. The final mould-area is templated with iron rods and it is provided with a suitable dirt-trap. The mould of the boss is roughly shaped with a hard wood template.

First Drying.—The mould is then removed to a stove or oven, where it remains until sufficiently dry for proceeding with the second course. It is very important to control the temperature of the drying-stoves; if the heat be too fierce the surface of the wet loam hardens rapidly into a crust, which must crack excessively to permit the steam from the moist loam beneath to escape from the mould. The first drying, while it should be thorough, is of less extreme heat than the second or third drying. It is found economical in foundries which contain two or more stoves, to use one of them for moderate drying, and so on.

The Second Course.—The mould is withdrawn from the stove after one night of drying; sometimes two nights are allowed for very heavy moulds. The mould is then replaced exactly in its original position on the floor plate, and the pitch-piece is adjusted. The surface of the mould will be found to have cracked and expanded in drying; this necessitates "knifing." Knifing consists of working the striking-edge over the surfaces of the mould until the roller of the board runs evenly on the rail of the pitch-piece; thus a helical incline is produced, true to pitch. The correctness of this pitch must be tested by pitch-templates before any further building is proceeded with.

The section-pieces are now fixed in their allotted positions, the point where they intersect the centre-line being marked on each of them; they are secured vertically by nails or wooden brackets. Pieces of wood cut to the casting thickness of tip

are fixed against the tip section. The outline of each blade is now marked out round the extremities of the section-pieces.

The blade pattern thus formed by the section-pieces is filled in with bricks and dry sand; slightly rammed and finished off with smoothing-trowels. Sometimes the pattern is lightly brushed with water to harden its surface; and then the whole is freely sprinkled with powdered plumbago or "parting sand." The latter is ordinary fine moulding-sand from which all the "combined-water" has been removed; hence no addition of moisture can restore its binding powers. It is commonly obtained by removing the burnt sand from the cooled surface of open iron castings.

Building the Top-Moulds.—The top-moulds consist usually of an iron "grid" or wicker-work, filled with loam, and suitably strengthened with wire; it is finally bricked to meet a top-plate—one for each blade—which is horizontal and so is parallel to the bottom casting plate. It is bolted and clamped to ensure its unbroken removal. With small propellers the top-plates are often not used, the brickwork walls, strengthened by strong iron wire, being considered sufficiently rigid. Grids, however, are not universally used, and the top-mould is often re-inforced with iron rods only. The grid has, none the less, very definite advantages—it is stronger, it is easily adjusted, and it requires much less thickness of loam, usually about 2 in. only, which facilitates drying to a very appreciable extent.

The "grid" consists of a cast-iron binder which fits on a seating on the top surface of the bottom portion of the mould, and is provided with two rings for lifting, and two large lugs on which the top-mould stands when removed for dressing. Cast into the form or binder are a large number of iron rods, fixed in line along its inner edge at intervals of about 2 in.: these can be bent to fit the back of the blade-pattern; they are crossed, approximately at right-angles, by other rods, and the whole is securely wired, so that the grid is rigid and strong. The cross-irons towards the root of the blade are bent to form a reinforcement for the wall of loam around the boss.

To adjust the grid in position, wooden blocks between ½ in. and ¾ in. in thickness are placed upon the seating and upper edge of the mould. The grid is fitted on these blocks, its irons bent to the required shape, the cross-irons securely wired, and a third ring for lifting fixed to its upper part. The grid, together with the blocks, is then removed, a layer of loam is placed over the whole mould area, and the grid replaced in position and firmly bedded on the loam. It is then covered with a layer of loam, which is smoothed off after the walls supporting the top-plate have been built.

Striking up the Boss.—The striking-board for the boss is fitted on the spindle as the building of the top-mould proceeds: the clamping-collar is so adjusted that the tooth on the boss-board meets the centre-lines of the blade-faces, and the whole of the boss is struck up. After the top-plates have been adjusted, if such be used, and the necessary bolting has taken place, the boss-board and spindle are removed.

Second Drying.—The mould should now be stoved for, roughly, thirty-six hours, covering two nights.

Preparation of the Mould for Casting.—After the mould is withdrawn from the stove, the interior of the boss is chipped out along the lines where parting will take place: this facilitates the clean removal of the top-moulds. It is of great importance that the crane should be capable of very delicate handling, and that the operator should exercise much care in lifting and replacing the top-moulds; otherwise considerable damage from shock and consequent cracking may be sustained by the mould. After parting the mould, the top-plates are supported on the ground in an almost vertical position, and rest on the before-mentioned lugs of the grids. The brick and loam pattern and the section-pieces are now removed with as little damage as possible to the faces of the mould; the surfaces of the mould are then made good wherever necessary. The fillet curves are cut away to template and the curved surface rubbed smooth. The faces of the mould are likewise smoothed, the blade edges are trimmed and finished, and all unevenness of surface, due to any patching, etc., is removed. The openings of the test-bar recesses are similarly trimmed. The boss is also rubbed down and finished. All the interior surfaces of the mould are now "washed" and finally dressed.

Third Drying.—The tops are replaced upon the mould, but are kept from contact by bricks placed on the seating and edges; thus during drying the hot air of the stove will be able to gain easy access to all parts of the mould. Care should be taken when moving finished moulds in and out of the stoves to avoid shocks, such as might occur through uneven floors or rough handling, as any carelessness may result in serious cracking of the mould. The mould is withdrawn after one night in the stove. The top-moulds are lifted off and the mould thoroughly brushed to remove any dirt or sublimate; any remaining dust is removed by compressed air. The tops are now replaced with great care, their edges being adjusted by means of marks previously made. The joins to the bed should be made up with loam.

The assembled mould must be firmly clamped to preclude any possibility of bursting or slipping. If top-plates are used, these are secured to the bottom casting-plate by long bolts; and suitable girders are placed across each blade and bolted to the bed-plate also. If, as in the case of smaller propellers, no top-plates are used, the girders alone are considered to give ample resistance to the bursting force exerted by the molten metal. The mould must be secured against collapsing and slipping—that is, against the tendency of the top-mould to move—down the bed; this is obviated by fixing metal bars vertically between the plates, wedged to the required distance, and wired to the clamping-bolts. When the mould is placed in the casting-pit the vertical portion of the runner should be built up securely, and the whole mould surrounded by rammed sand and interlocking plates, if available. The sand should be very tightly rammed at all joins where the tops meet the bed; this prevents any escape of metal. Around the boss all joins are carefully filled with loam and dressed. The head-mould is now placed in position; it consists of a wide collar of brickwork held between two rim-plates, from 10 in. to 30 in. in depth, according to the size of the propeller. It should be the same diameter as the top of the boss, and be placed concentrically. The join of the boss and head must be finished with loam, and carefully dressed.

Final Drying.—To ensure complete dryness of the mould, particularly where the loam has been recently added, local drying must be resorted to. Red-hot weights of cast-iron are suspended from a bar placed across the mouth of the head. The mouth is then covered with a piece of sacking to enclose the hot air. Fresh weights should be added as necessary, so that the mould shall be as warm as possible at the time of casting.

After the final drying of a mould for a propeller of large size, a core is fixed into position. The core consists usually of a "core-barrel," *i.e.*, a long perforated iron tube, surrounded by a spirally wound straw-rope, which itself is entirely enclosed in specially prepared loam. The core tapers from bottom to top, and it may carry any specified modifications such as the cores of "lightening-chambers." The core thus struck up is washed and dressed in all respects similar to the mould itself. It must be fixed absolutely concentric with the boss form

The vertical portion of the runner is now completed with specially prepared hollow cylinders of loam. This is built up securely to a height just above the overflow level of the head. The runner-box, which will be described later, is fitted and secured: it is of special importance that the runner be thoroughly dry. Care must be taken to guard against any escape of metal at the joints in the runner, and between the runner-box and the runner.

Provision must be made for a "flow-off" from the head. A channel should be constructed leading into a pig-bed of suitable size, in order that the surplus metal may be recovered in a form convenient for recharging into the furnace.

THIRTY-THREE steamers were built by the Osaka Ironworks, Limited, Japan, during 1920. The gross tonnage totalled 84,979. Four of the vessels were for American owners and the rest for Japanese.

Hints for Young Patternmakers.

By BEN SHAW.

A good all-round patternmaker should have a thorough knowledge of drawings, be no mean draughtsman, and the greater his mathematical and mechanical knowledge the better chance he will have of a better position. He must be possessed of initiative to determine the construction of any given piece of work, consistent with strength and durability and the quantity of castings required.

The grades of timber used should vary with the work, especially is this necessary under the present conditions of timber supply. Patterns from which only one casting is to be made, with little prospect of more being required in the future, can be satisfactorily accomplished with cheaper material, providing the timber is sound. When many castings are required and standard patterns are constructed, the timber cannot be too good. Whatever variety of timber is used, of whatever grade, whether Nos. 1, 2, or 3 quality, it should be well seasoned.

It is no economy to make and use patterns composed of timber such as is sometimes used, where the water will ooze out in front of a chisel cut, or fly in the worker's face when being turned in the lathe. Patterns made from such material never give satisfaction, and, if wanted again for repeat orders, need considerable cleaning up to make them mouldable; if this is not done, a clean withdrawal from the sand is impossible and involves extra time in patching up.

In the construction of patterns accuracy is one of the essential requirements of every patternmaker. Speed is certainly an important factor, but if accuracy is sacrificed to speed, it is frequently the cause of much inconvenience to other departments which reflects upon the pattern shop, besides being responsible for much valuable time and considerable loss of money. Coupled with the need for accuracy is the requisite skill to provide a pattern, which can be moulded satisfactorily.

When permanent standard patterns are required, such as, say, valves of various kinds, sizes and shapes; too much care, within reason, cannot be expended upon the work. Parts should be well fitted together and the proper amount of taper given. If the patterns are in halves see that they are dowelled together serviceably so that they maintain their relative positions when assembled and in the mould, and yet are quite free to be easily separated. It is necessary to secure a sufficient number of rapping and lifting plates in order that the withdrawal from the sand will have the least possible effect upon the patterns. This latter item is often neglected and only brought to the patternmaker's notice when he sees the results of the moulder's spike.

It is essential to provide core-prints of sufficient length to sustain the weight of the cores without crushing the moulds. The patternmaker who constructs the boxes from which intricate cores are made and which are correct, fitting the mould exactly and giving the required thickness of metal, has solved one of the most difficult problems in patternmaking. Indeed, no patternmaker can be considered successful unless he has acquired the faculty of having cores from his boxes well fitting and correct, as, more frequently, greater skill is required in making core-boxes than patterns: moulders probably recognise this more than anyone.

It frequently occurs that a pattern is wanted for only one casting; there are workmen who do not seem to appreciate this fact—they spend as much time on the pattern as though a hundred were required. A patternmaker is expected to use judgment in turning out his work economically. In such cases strong, substantial patterns are not necessary, sufficient strength to retain their rigidity while being rammed, and to ensure their safe delivery from the sand would be satisfactory. Instances of this kind give the patternmaker opportunities for showing his ability to discriminate between different classes of work and his value increases according to his capacity for devising the cheapest methods of construction.

A smart patternmaker is always on the alert for any errors which may appear on the drawing; it encourages confidence in his work and demonstrates his ability to read drawings.

In the making of patterns it is customary to use glue to secure the component parts permanently together, but there are many patterns which could and ought to be made with the minimum amount of glue. Where glue is exposed to the damp sand trouble is invariably caused. In the case of pattern work which is to be moulded in loam, no glue should be used unless it is protected with paint or shellac. The proper construction of patterns, not only from the point of strength, but also with due regard to the easiest and least expensive method of moulding, is the desirable thing in patternmaking, consistent of course with the production of the best castings the circumstances demand.

The expense of a costly pattern can frequently be avoided by sweeping up work in the foundry, it is therefore of considerable advantage to a patternmaker to acquire as much experience as possible of foundry practice in its relation to patternmaking. Economies invariably result when the patternmaker and moulder are working in conjunction with each other.

Shrinkage of castings is a very important item to the patternmaker, the amount varying, not only with the different metals of which the castings are to be composed, but also with different classes of work in the same metal. Thus complicated work of large proportions contracts less than a plain job, other things being equal. Moreover, different foundries require different co-efficients of contraction for their mixtures, especially is this so with the mixtures used for steel castings. Text books give only approximate allowances for contraction, these are undoubtedly quite suitable for the general run of small and medium sized work, but for large work experience usually determines the amount likely to give the most satisfactory results.

The construction of suitable patterns demands the services of highly skilled craftsmen, and, as the conditions vary in different districts, considerable versatility is desirable. To be a convincing patternmaker under all conditions is essential.

These few hints are written in the hope that they may assist many of the younger members of this interesting trade to a better understanding of its requirements.

Electric Ingot-Stripping Cranes.

We have received from Thomas Broadbent & Sons, Limited, Huddersfield, particulars of two 10-ton ingot-stripping cranes installed at the works of the Redbourn Hill Coal and Iron Company, Limited, Scunthorpe.

Both cranes are identical, each having five motors, a lifting height of 40 ft. and a span of 68 ft. 6 in. Each crane is equipped as follows:—

The stripping and hoisting motors develop

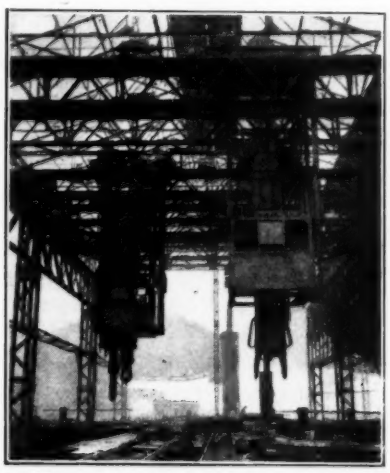

FIG. 1.—ELECTRIC SHIPPING CRANES AT THE REDBOURN HILL COMPANY'S WORKS AT SCUNTHORPE.

50 h.p. at 500-550 r.p.m., the latter giving a hoisting speed of 25 ft. per min. Transversing and turning are carried out by 15-h.p. motors running at 500-550 r.p.m., traversing being effected at a speed of 80 ft. per min., while a turning speed of 10 ft. per min. is obtained. The travelling motor, which develops 50 h.p. at 500-550 r.p.m., provides a travelling speed of 200 ft. per min.

The whole of the electrical equipment is designed for 440 volts direct current.

ARC BURN.—In the Reports of Investigations United States Bureau of Mines, Dr. C. R. Kendall advocates that at every plant where electric arc-welding outfits are used there should be an adequate supply of glasses, the lenses of which are made up of alternate layers of red and blue glass or orange glasses of sufficient thickness to protect the eyes from the effects of ultra-violet-rays. There should also be on hand at the plant dispensary or hospital a supply of boric acid, sterilised water, ordinary table salt, argyrol and protargol for immediate use. All cases of traumatic conjunctivitis caused by exposure to bright light or ultra-violet rays should be treated under the direction of a physician.

Institution of British Foundrymen.

SHEFFIELD BRANCH.

At a meeting held at the Cutlers' Hall, Sheffield, on February 9, under the chairmanship of Mr. J. R. Hyde, a lecture on "The Value of Scientific Research to the Foundry" was given by Mr. F. C. A. H. Lantsbery.

The Value of Scientific Research to the Foundry.

In the course of his remarks the lecturer said there was probably no industry which offered a more fruitful and promising field for research than that connected with production of castings. Cast iron was a most complicated material, with about nine variables entering into its composition. The difficulties of investigation were great enough to the scientic worker; how much more so must they be to the practical man who had to deal with the material? As a matter of fact, the troubles of the foundryman who had to deal with cast iron certainly began in the blast furnace, and it was quite possible that in some instances they originated even before the material got into the blast furnace. Then the composition of the materials employed in the blast furnace influenced the pig-iron produced, as also did the temperature which prevailed in the furnace, the temperature of casting, and the method of casting employed. The rate of cooling and the speed of running the furnace had a most important influence on the character of the pig-iron, which influence was not always determined by chemical analysis. Such analysis was undoubtedly of the highest importance to the foundryman, but the rate of running the cupola might easily influence the type of cast iron produced. He had frequently had brought to his notice cases in which, although there was no change at all in the mixture, the cupola at one moment would be running a perfectly grey iron and a few moments afterwards a white iron, without any apparent reason for the alteration. In the foundry the selection of materials played an important part in determining the character of the product. The variation which might take place in the type of iron produced during melting was probably due to the combined effect of temperature and time. Little was known at present about the expansion and contraction of irons, and the probable effect on the stresses which were set up in the castings; and the rate of cooling of the casting had a very material influence, about which very little was known. There was no doubt that in the abstract the great majority of foundries in this country were agreed that it was desirable that they should get a much closer co-operation between themselves and the scientific worker.

Referring to the British Cast-Iron Research Association, the lecturer remarked that the Institution of British Foundrymen had played a very important part in its formation, and it was highly important that it should continue to play its part now. The preliminary council considered it highly important to get into the Association everybody who was connected with iron founding, and therefore it had established a very low limit of subscription. The minimum was somewhere in the order of £5. But they had also arranged that the subscription would be paid upon the labour employed, and that was the fairest way of assessing iron founders.

THE BRANCH-PRESIDENT said the Universities had told them a certain amount about steel, but cast iron seemed to be too humble for them to tackle. Mr. Lantsbery had carefully focussed their attention on the various points in which the Cast-Iron Association could help them. There was, no doubt, a tremendous amount of information published, and the idea was that this should be gathered by a collecting committee, who would use a card index system, and would provide condensed reports which would be available for the members of the Association. If any of them had any difficult problems it was up to them to communicate with their Secretary, who would put them in touch with the Association Secretary. Let them persuade all the local firms to be members, and then, if a problem cropped up, suggest that it was a thing that might be tackled by a Government Research Department to the mutual advantage of everybody.

SCOTTISH BRANCH—FALKIRK SECTION.

A meeting of the above section was held on January 22, MR. ROBERT CLARK, president of the section, introduced Mr. David McQueen, who read a paper on "Moulding Sands and Facings."

Moulding Sands and Facings.

MR. MCQUEEN at the outset referred to the principal sands used in foundry practice, such as Erith, Belfast, Mansfield, and those found in the Falkirk district. He next dealt with the chemical composition and physical properties of moulding sands generally, explaining that the chief constituents were silica and alumina, with small percentages of lime, magnesia and other elements. The essential constituents, however, were silica and alumina, the other elements were regarded as impurities and had a deleterious effect on the casting. Silica, being a highly refractory material, was a necessary constituent in all moulding sands in order that they may be able to resist the penetrating action of molten metal.

Alumina or clay was required to give cohesiveness to the sand, in order that it would have sufficient strength to retain its shape during the process of constructing the mould, and also that the mould may retain its form during casting.

A certain amount of water was also necessary in moulding sand to complete the bond. Care has to be exercised in the selection and preparation of a moulding sand for green-sand work, in order that it may perform its functions correctly; a sand containing too much clay, or with excessive moisture, would prevent the escape of the gases generated at the time of casting, and would result in blown or scabbed castings.

Porosity was another essential property in a moulding sand, and the lecturer referred to the importance of this property in the casting of pipes and other hollow-ware castings made in green-sand. In such work it was necessary that the cores which were in ordinary green-sand should be rammed to the correct degree of intensity and yet be open enough to allow the gases to escape.

Mr. McQueen then referred to the various tests applied in judging the suitability of sands for foundry work.

In selecting a sand it was necessary to consider its chemical composition and its physical properties. Much information regarding sands could now be ascertained by subjecting them to a microscopical examination. The degree of coarseness or size of the grains could be determined by sieving the sand through a number of sieves with varying sizes of mesh.

The lecturer stated that dry-sand moulds should not be dried at too high a temperature, as the combined water would be driven off and cause the mould to be easily injured. For small cores in jobbing work, free sand used in conjunction with an artificial binder gave splendid results.

Mr. McQueen then briefly referred to the subject of foundry facings, among which the following materials were considered; coal dust, wood blacking, mineral blacking, plumbago and soapstone. Coal suitable for coal dust should be low in ash, as this added an objectionable material into the sand. The volatile matter should be fairly high, as this is the chief difference between coal dust and other carbon facings.

For the production of wood blacking, oak was the best wood to use, and the substance known as mineral blacking was generally obtained from a residue found in retorts used for extracting oil from shale; mineral blacking contained a high percentage of carbon.

Plumbago was a natural product, containing a high percentage of carbon in the form of graphite, and was an excellent facing for heavy work.

The primary object of a facing was to produce a clean surface on a casting, and this was brought about in the following manner:—When the molten metal came into contact with the face of green-sand mould the water present was split up into its components, hydrogen and oxygen, the carbon in the facing combined with the oxygen and formed a gas, which in turn formed a thin insulating film on the surface of the mould, and in this way prevented the molten metal fusing with the sand.

XUM

Trade Talk.

JOHN HENRY ANDREW & COMPANY, LIMITED, of Sheffield, have closed their works indefinitely.

A FIRST-HAND steel smelter who appeared before the Middlesbrough magistrate for not supporting his wife and children was stated to earn £28 a week.

A PARTY of engineering students from Edinburgh University visited Rosyth Dockyard last week, and were conducted round the yard and workshops.

BLACK COUNTRY blank bolt-makers have accepted a reduction of 10 per cent. in wages to enable the trade employers to compete with foreign manufacturers.

IT is announced that the St. Saviour's Wharf, Dockhead, London, S.E., has been registered as a metal storage on the official list of the London Metal Exchange.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN held their fourth meeting of the session in Sheffield, when Mr. C. W. Davis, of Leeds, lectured on drop forgings.

BEFORE the members of the Sheffield and District Branch of the Institution of British Foundrymen, Mr. J. S. Robinson, of Halifax, delivered a lecture on "Core Stoves and Mould Drying." Mr. J. R. Hyde presided.

THE eighty-seven members of the Institution of Mechanical Engineers who were killed in the war are commemorated by a tablet which was unveiled by Captain H. Riall Sankey, the president, on February 17.

MR. JOHN TRAIL, M.I.M.E. (66), late of Grosvenor Place, Newcastle, chief marine superintendent of the Prince Line of Steamers, formerly manager of the Globe and Albion Dry Docks, Swansea, left £10,766, with net personalty £9,704.

THE UNITED STEEL COMPANY, LIMITED, Workington, are closing down on March 4, solely on account of the price of coal. Belgian steel can be bought here at £6 per ton, while it takes 6 tons of best coal to make a ton of English steel.

IT is announced that experiments have been made with great success at the Skinningrove Ironworks, on Tees-side, with a view to the extraction of potash from blast-furnace gas. It is said to be an entirely new development in this country.

AT an ordinary meeting of the Institute of Transport held at the Institution of Civil Engineers, Great George Street, S.W.1, on Monday, Sir Philip Nash read a paper on "Electrification of Main-Line Railways in Relation to Traffic Working."

SHIP-REPAIRING on Tees-side, although rather more in evidence of late, has now become abnormally intermittent, and the total volume of business is being much reduced by the large number of vessels which are completing voyages, only to be laid up.

THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS has accepted the invitation of the Scottish Institution to hold a summer meeting in Glasgow in June next and the dates provisionally fixed for the meeting are June 22, 23, and 24.

THE next meeting of the Institution of Automobile Engineers will be held on Wednesday, March 2, at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W., when Dr. W. H. Hatfield will read a paper on "Automobile Steels."

ON Saturday the members of the Newcastle and District branch of the Institution of British Foundrymen met at the Neville Hall, Newcastle-on-Tyne, when a paper was read by Mr. F. J. Cook (past-president), of Birmingham, on "Mechanical Tests for Cast Iron."

IT is announced that a contract for a large number of 30-ton liquid fuel bogie tank wagons has been placed by the Egyptian State railways with Clayton Wagons, Limited, Lincoln. Tenders had been invited from all the leading British, Continental, and American makers.

AT a social meeting of the employés of Messrs. Henry Robb, Limited, ship repairers, Leith, Mr. Robb spoke of the difficulty experienced by shipbuilders in securing repair work owing to foreign competition. He found that their most redoubtable opponents were foreigners, Germans included.

A MEETING of the Merseyside Branch of the Association of Engineering and Shipbuilding Draughtsmen was held on February 17 in the Walker Engineering Lecture Theatre of the Liverpool University, when Mr. J. B. Redfern read a Paper, prepared by Mr. G. G. Dobie, on "Hydrophones."

FOLLOWING a recent meeting of the directors of the Dominion Steel Corporation and the Nova Scotia Steel and Coal Company, it was announced that agreements had been reached for the consolidation of these concerns with Halifax Shipyards, under the name of the British Empire Steel Corporation.

A DISPUTE which led to a lock-out of moulders employed by Messrs. J. Pickles & Sons, engineers, Hebden Bridge, has been settled, and work has been resumed. The arrangement made is for a later start and a later finish of work, when blowing operations are necessary, overtime thus being avoided.

AT the Central Schools, Sheffield, industrial chemists listened to a very able paper on "Combustion," read by Mr. Sargent, of Messrs. Hadfields, Limited. Mr. Sargent dealt with the latest research as well as early history of combustion in the firing of boilers and furnaces, and anything where flame was used.

THE SWANSEA CORPORATION have under consideration a scheme to extend the Corporation electrical supply to the area of the Amman Valley. Several works and collieries in the area are seeking power and light, while Ammanford, Gowerton, Gorseinon, and Pontardulais come within the scope of the scheme.

THE second monthly meeting of the Royal Technical College Metallurgical Club was held last week, when a paper was read by Dr. Hatfield, D.Met., Sheffield, on "The Manufacture of Steel." Two films were shown, giving details of the different processes through which the metal passes before being finally dispatched from the works.

IN view of the time necessary for obtaining the further information required for dealing with the scheme submitted for the lower Severn electricity district, the resumption of the local inquiry at Bristol provisionally arranged for March 1 has been postponed. A further announcement as to the date will be made in due course.

AN agreement has now been reached in connection with the offer of the Sheffield Engineering Employers with regard to shift work. The terms of the settlement are as follows:—For morning shift, 47 hours to be paid for and 43 to be worked; afternoon shift, 47 hours to be paid for and 37½ worked; night shift, 50 hours paid for, 37½ worked.

A CONFERENCE of the Shipbuilding Employers' Federation was held at Edinburgh on Friday last. This was one of a series of meetings for the purpose of reviewing the whole position of the industry, cancellations, suspensions of work, etc., and also to see how best they could alleviate the position and help both employers and employés.

SPEAKING in Sheffield, Mr. W. L. Hichens, chairman of Cammell, Laird & Company, Limited, said he did not believe that a single order had been placed with a shipbuilding firm in this country in the last six months. Bad though things were, he thought if we could make a really substantial reduction in the cost of ships we should be getting orders in a short time.

"THE HUMAN PROBLEMS OF INDUSTRY" is the subject of a conference which is to be held at the Mansion House on March 2, with the Lord Mayor in the chair. The conference is being called by the Industrial Welfare Society, the principal speakers being the Duke of York, the Home Secretary, the Minister of Education, Mr. Clynes, Sir Charles Wakefield, and Sir William Ellis.

THE annual dinner of the Edinburgh, Leith, and District Ironmongers', Blacksmiths' and Master Sheet Metal Workers' Association was held in Edinburgh on Friday last. Mr. R. Adams occupied the chair, and those present included Messrs. J. Doig, W. Shaw, J. King (chairman of the National Light Castings Association), and A. Horsburgh Campbell (Director of Housing).

A FURTHER addition to the contributions on steam turbines contained in the "Transactions" of the North-East Coast Institution of Engineers and Shipbuilders was read at the meeting in Newcastle on Friday last, this being a Paper on the losses in convergent nozzles, by Professor A. L. Mellanby and Mr. Wm. Kerr. Mr. A. E. Doxford (president) occupied the chair.

SORBY SCIENTIFIC SOCIETY (Geological Section) recently made an excursion to the ganister mines and quarries in the lower part of the Loxley Valley, under the leadership of Mr. J. Lucas. This district has a particular interest to Sheffield geologists as the original source of the ganister which has played so important a part in the development of Sheffield industries from the time of Huntsman to our own day.

IT is stated that the Iron and Steel Trades Confederation have already distributed by way of unemployment relief to its members during the present industrial slump the sum of £110,000, and although this appears a large amount in view of the fact that it is in addition to State relief, it is pointed out that the Confederation, not having been engaged in industrial struggles to the same extent as many other organisations, is better able to withstand the heavy drain on its finances.

MR. J. H. LONES, J.P., general manager of the Blaenavon Works, was elected chairman of the South Wales and Monmouthshire Iron and Steel Manufacturers' Association at a meeting at Cardiff. Mr. Lones, in proposing a vote of thanks to the retiring chairman (Mr. Howell R. Jones, J.P.), commented upon the excellent manner in which the work of the Association had been carried on during what he considered to be a most trying term of office. Mr. N. K. Turnbull, chief engineer, Ebbw Vale Works, was elected vice-chairman of the Association

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21st February, 1921.

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.....

We cordially invite everybody interested in Foundry Equipment to visit the above Fair, as we are most anxious that all should avail themselves of this opportunity of seeing our exhibit which appears as near as possible to a working Foundry.

There are six Foundry experts in attendance to give you assistance and advice on that job which is causing you trouble. It is an undeniable fact that our Equipment will show you a financial saving in your Foundry.

We are exhibiting Moulding Machines, Core Machines, Sand Mixers, and a large variety of Pattern Plates, all of which embody the most up-to-date and time-saving features.

A large number of Castings made in Aluminium, Bronze, Brass, Grey Iron, Malleable Iron, Semi-Steel and Steel will be there, showing the sound and clean finish.

The Constructional Engineering Co. Ltd. (with whom we are having a joint exhibit) are showing Cupolas, Ladles, Sand Mills, and Core Ovens. We would advise you to visit our Stand before you get too tired looking at other excellent exhibits which will not prove so remunerative to you as ours.

It will be to your advantage to make a special effort to attend the Fair, and if you will write, stating the number of tickets required, we shall be only too pleased to send same on to you.

In the event of your being unable to visit the Fair, write for our new catalogue, which will give you illustrations of the Equipment we are showing at the British Industries Fair, Birmingham.

XUM

IRON AND STEEL MARKETS.

Pig-Iron.

Complete stagnation of demand, both home and export, continues the dominant note in pig-iron markets, which during the week has prevailed throughout the trade, and from all appearances offers very little prospect of a change for the better. In the Cleveland area, a recognised index to the conditions of the pig smelting industry, reduced production is evidently the order of the day, makers already working at a loss, having determined on the alternative of throwing plants idle in preference to continuing operations, amongst the latest to adopt this course being one furnace at Carlton and another at Messrs. Whitwells at Thornaby. At least two have also gone out at Messrs. Bolckow, Vaughan's Works, and it may be that of the eight blowing last week more will have to close down. At the end of January there were 72 blast furnaces operating on the North-East Coast. Now there are reported to be not more than 56. Smelters, already selling below a profitable basis, consider that they have gone as far as they reasonably can in the direction of price reductions, yet their quotations are still pounds per ton more than those of Continental producers, and as consumers naturally seek the cheapest market in which to buy. Reports from South Staffordshire mostly correspond in substance with other districts in which pig-iron markets are situated, cost of production still remaining an effective barrier to anything like a considerable reduction in prices sufficient to stimulate an active demand.

The East Coast hematite pig-iron trade is reported to be rather stronger under the influence of some inquiry both from home consumers and for export. The small sales reported, however, are confined to the home trade, and as yet no business has resulted from the foreign inquiry.

Scrap.

From all the chief centres of the scrap trade reports unanimously describe the position at present as practically hopeless from the business point of view, even the best qualities of this material finding little favour with buyers, while prices for most descriptions of metal may be regarded as nominal. Few works are taking delivery of material bought, and are certainly not entering into new commitments. No selling figures are available, but so stagnant is the market that dealers are said to be willing to do business at not much above the prices which operated before the war.

Steel.

No alleviation in the depressed conditions of the steel trade is as yet apparent, and from present indications it would seem that it will take some time before activity is restored to normal levels. As far as Sheffield, the principal centre of the home industry, is concerned, the outlook is very far from encouraging, the slackness in the heavy branch of the steel trade being reflected in the official returns of production during January. The total of 493,000 tons is 34 per cent. less than in December, and 260,000 tons less than in January of last year. It is a good deal below October and November, which, owing to strikes, were by far the worst months of last year. Foreign competition is seriously affecting business, a substantial order for rails by a Welsh railway having been placed at £12 12s. 6d. with the Belgians, against £19 quoted by local manufacturers.

Finished Iron.

Manufacturers of finished iron, in common with many other branches of industry, are experiencing a continual lack of demand, and with the possible exception of makers of marked bars, works are mostly running at greatly diminished capacity. Only a limited volume of orders is now coming forward for all descriptions of finished material, and with the majority of old contracts approaching completion the outlook is far from encouraging to makers. There is, of course, keen competition for any fresh business coming forward, although as a rule producers are adhering loyally to the agreed prices, but in the case of second hands anxious to dispose of holdings no such restraint is observed. Consequently the new basis price of £17 recently announced by bar makers for small rounds, untested, had already been anticipated in actual market business for some time past. In the South Staffordshire district bar-iron firms are doing nothing, even deliveries of Belgian bars have moderated, though that is due to labour troubles in that country. Firms which have withdrawn from the Iron-Bar Association are offering at £24 10s., which is £2 below the Association price, and naturally there is a good deal of dissatisfaction. Cable iron, which has to undergo a severe test, is in slow inquiry, owing to the slump in the consuming industries in the Cradley district.

Refractories.

This week has shown a little improvement in the demand for most classes of refractory materials, and though supplies of imported sands are very plentiful, the demand for home moulding sands shows considerable improvement, and prices are a little easier where firms are prepared to place orders for regular deliveries or contracts up to the end of the half-year. There has been a slight reduction in the price of silica bricks, the demand for which is very low.

Magnesite bricks are still in good demand, especially on the Continent, prices remaining firm at the figure quoted in our last issue. Generally speaking, manufacturers are holding good stocks of all classes of refractory materials, and are able to deliver promptly.

Ordinary silica bricks, 2½ in., are now quoted at £14 18s. 6d. per 1,000, f.o.r., with 3 in. at £17 18s. 6d. per 1,000, f.o.r.

Tinplates.

The prevailing impression in tinplate trade circles to-day is that matters are going steadily from bad to worse, and that any hopes of a speedy recovery are doomed to disappointment. Tinplate prices continue to give way, and although a few works are going to-day and ceasing operations to-morrow, in producing plates for stock, so as to afford some little employment for the thousands of hands who are now idle, the period is fast approaching when the whole of the tinplate works will be at a standstill unless an improvement in buying rapidly sets in. There is at present an almost total absence of any general buying, and small parcels of tinplates that have changed hands both on home and foreign account show a further cut in the price of as much as from 1s. 6d. to 2s. per box. As low as 28s. 6d. per basis box, f.o.b., has been accepted, and it is reported that some remarkably low quotations have been taken for waste quarters, in one case 15s. having been accepted for a small quantity of these specifications. Ternes are again easier at 60s. basis, f.o.t. works. Current quotations for tinplates are: Cokes, 20 by 14, 28s. 6d. to 32s. 6d.; do. quarters, 32s. 6d. to 34s.; cokes, 20 by 10, 44s. 6d. to 46s.; do. 28 by 20, 57s. to 65s.; ternes, 28 by 20, 60s.

Returns of the production and consumption of Welsh tinplates during the past three years have been issued showing that the output in 1920 was 13,935,421 basis boxes, compared with 12,386,326 basis boxes in 1919, and 8,808,272 basis boxes in 1918. The deliveries from works last year amounted to 12,215,260 basis boxes, against 11,039,966 basis boxes in 1919, and 8,888,700 basis boxes in 1918.

Metals.

Copper.—This week's markets for copper opened again with an easier tone, and, so far, are without apparent signs of any substantial improvement in the position of standard metal. Consumers, both at home and abroad, appear to be resolutely holding off from a general buying movement, operators, for the most part, confining attention to the more speculative side of the business. Values, meantime, continued on the down grade, three months opening with a loss on balance of 20s., closing fractionally better at 15s. decline, and cash 20s. lower. Closing prices:--Cash: Wednesday, £70 15s.; Thursday, £70; Friday, £69 5s.; Monday, £69 5s.; Tuesday, £68 5s. Three Motnhs: Wednesday, £70; Thursday, £69 5s.; Friday, £68 5s.; Monday, £67 10s.; Tuesday, £67 15s.

Tin.—Latest cable advices from the East, reporting that tin in that area is now free of control, thus indicating that the "pegged" price had been abandoned, stimulated some aggressive selling at Monday's opening market on this side, and values rapidly receded, buying offers at £184, c.i.f., eliciting but a poor response. Closing prices:—Cash: Wednesday, £169; Thursday, £168 10s.; Friday, £165 10s.; Monday, £159 10s.; Tuesday, £158. Three Months: Wednesday, £172 10s.; Thursday, £174 15s.; Friday, £169 10s.; Monday, £163 10s.; Tuesday, £162.

Spelter.—A steady decline in values of this metal last week was continued in Monday's opening market, when forward spelter was quoted 5s. lower on balance, with sales on a comparatively limited scale, prompt

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

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ordinary brands marking £23 15s.; English, £27; electro, 99 per cent., £33 5s.; prime Westerns, £24 5s.; remelted, £19 10s.; American (St. Louis) spot, 4.80c., £25 18s.; zinc dust, 92-94 per cent., nominal, £60 to £65; zinc ashes, 70 per cent. nominal, £6 5s.

Lead.—The week's market opened with an upward tendency in values, soft foreign being quoted £17 10s., closing sellers, £18 7s. 6d., buyers, £18 2s. 6d. English lead, after a period of weakness, was firmer at £19 10s., an advance of 10s. over the closing quotation of last week

Company News.

United Strip and Bar Mills, Limited. — Half-yearly dividend on preference at rate of 8 per cent. per annum, less tax.

Mather & Platt, Limited.—Including £26,745 brought forward, net profit for last year amounted to £230,456. Final dividend of 7 per cent., making 10 per cent. for year, and £105,457 forward.

Swan Hunter & Wigham Richardson, Limited. have declared a final dividend of 3 per cent., less tax, on preference shares, and final dividend of 5 per cent., free of tax, on the ordinary shares.

The report of the **Wigan Coal & Iron Company, Limited,** shows a profit of £238,571, and £93,136 was brought forward; final dividend of 6 per cent., making 10 per cent., tax free, for the year; forward, £150,735.

United Steel Companies, Limited, have declared an interim dividend of 3 per cent. on the ordinary shares, less tax, payable on March 21. The half-yearly dividend on the preference shares, at the rate of 6 per cent. per annum, less tax, will be paid on March 1.

Crossley Brothers, Limited. — Profits for the past year, subject to corporation tax, £59,111, plus £42,681 brought in. Final dividend on preference shares is announced, but nothing further on ordinary shares, on which interim dividend of 3 per cent. has been paid; £51,161 is carried forward.

English Crown Spelter, Limited.—Net results of the combined operations of mining and smelting, after bringing in an estimated net refund in respect of excess profits duty, show a loss of £36,484, which, added to loss of £3,126 brought forward, gives an adverse balance of £39,611 to be carried forward.

Sheffield Steel Products, Limited.—Certificates are now ready for exchange for allotment letters and bankers' receipts in connection with the recent issue of £1,000,000 10 per cent. preference shares. Application should be made to the secretary at the registered offices of the company, 14-16, Cockspur Street, London, S.W.1.

Lion Foundry, Limited.—Report states that balance at credit of profit and loss account, after making provision for depreciation, etc., was £17,584. Transferred £6,000 to reserve. Dividend recommended of 10 per cent. on ordinary and a corresponding percentage on deferred, together with a bonus of 10 per cent. on each class of share, all less tax, leaving £6,814 to be carried forward.

Gazette.

MESSRS. JAS. REED, Gilbert Walton Blakey, and Frdk. Parr, 205, Jack Lane, Hunslet, Leeds, engineers, trading as Reed & Blakey, have dissolved partnership. The business is continued by J. Reed and F. Parr.

MESSRS. THOS. BAKER, Joseph Lewis Loughton, and Gerard Turner, trading as the Anglo Iron Foundry, Middle Gate Entrance, Tyne Dock, South Shields, iron founders, have dissolved partnership. Debts by T. Baker and J. L. Loughton, who continue the business.

MESSRS. RILEY & HARBORD (Frank Wm. Harbord and Frdk. Jno. Bolt), 16, Victoria Street, Westminster, and 6, Finsbury Square, E.C., metallurgists and analytical and consulting chemists, have dissolved partnership. Debts by F. W. Harbord, who continues the business.

THE partnership hitherto carried on under the style of the Pontardawe Foundry and Engineering Company (David Joshua, Jas. James, Thos. Williams, and Wm. Bowen Williams), Pontardawe, engineers and founders, has been dissolved. Debts by D. Joshua and J. James, who continue the business.

MESSRS. THOS. WHITTAKER, Thos. Hepton Whittaker, and Lawrence Kershaw Whittaker, trading in the style of Thos. Whittaker & Sons, at Canal Foundry, Church, brick-making machinery makers, engineers, and ironfounders, have dissolved partnership. Debts by T. and T. H. Whittaker, who continue the business.

MESSRS. WM. HY. FELL, Christopher Southall, Arthur Smith, Alf. Allcock, jun., and Thos. Jas. Fell, The Foundry, Hunters Road, Handsworth, aluminium founders and casters, trading as the Premier Metal Casting Company and Alliance Aluminium Casting Company, have dissolved partnership. Mr. W. H. Fell will carry on the business on his own account.

Personal.

MESSRS. WILBRAHAM & SMITH, 8, Laurence Pountney Hill, London, E.C.4, have acquired the British business of Chas. Hatton & Company, Limited.

SCHOLEY & COMPANY, LIMITED, 56, Victoria Street, Westminster, S.W., have transferred their head offices to their Victoria Works, Gloucester Road, Croydon.

MR. J. MODERATE, who has held an appointment with Workman, Clark & Company, Limited, Belfast, for the past 14 years, has received an appointment with the Trinidad Central Oilfields, Limited.

MR. JOHN HODGE, M.P., has been presented with his portrait by the British Steel Smelters' Association, which is now part of the Iron and Steel Trades Confederation, of which he is president.

ALEXANDER, JACK & COMPANY, LIMITED, crane makers, Motherwell, have appointed Mr. W. Sharp their London district representative, with offices at 11, Pancras Lane, Queen Street, E.C.4.

MR. ALFRED FAIRLEY, of Birchfield Road, Handsworth, Birmingham, retired steel manufacturer, left £40,460, with net personalty £40,324. He left large bequests to charities and former employés in his late firm, James Shirley & Son.

MR. J. K. HOYLE has resigned his position as managing director of Aerial Ropeway Transporters, Limited, and commenced in business as consulting engineer on transport and conveying schemes at Granville House, Arundel Street, Strand, W.C.2.

DO YOU REQUIRE **CASTINGS** From 1 cwt. to 2 tons each?

The NORTHGATE IRONWORKS Co.

(Proprietors, R. Boby, Ltd., Associated with Vickers, Ltd.),

RAIL SIDING, BURY ST. EDMUNDS, SUFFOLK.

Finest Modern Foundry in the Eastern Counties.

Speciality: MACHINE MOULDING.

PROMPT DELIVERIES.

Telegrams: "CASTINGS," Telephone: No. 3, BURY ST. EDMUNDS.

FOR SALE

RIVETS

of all sizes,

surplus from cancelled contracts.

IMMEDIATE DELIVERY

F.O.R. Barnstaple, N. Devon.

Send Particulars of your Requirements to—

TAW SHIPYARD,

Barnstaple, N. Devon.

Also quantities of Steel Plates, Timber, etc., etc.

BAXTER'S

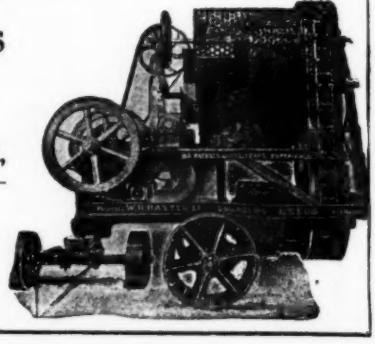
Patent Knapping Motion

STONE BREAKERS

UNEQUALLED.

Sole Makers:

W. H. BAXTER, LTD., LEEDS

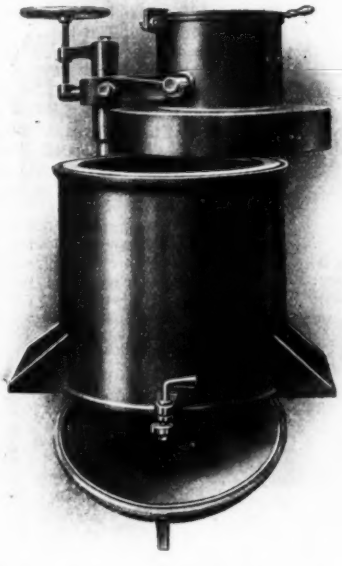


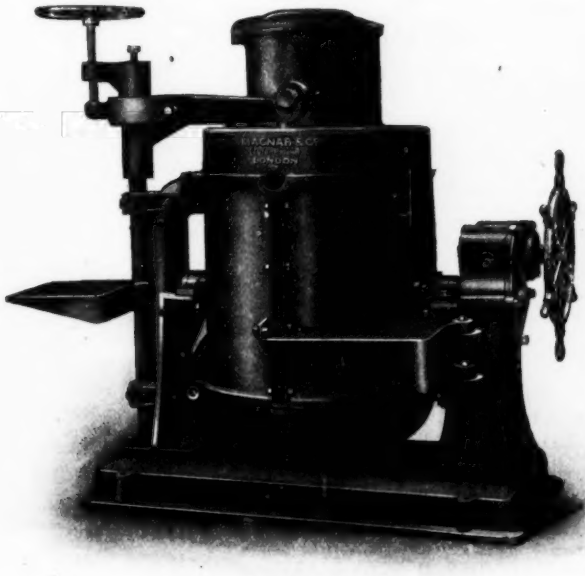
MACNAB & CO.

METAL MELTING CRUCIBLE FURNACE

For Brass, Gunmetal, Aluminium, Iron, etc.

Reduce your fuel cost! **Melt in a hurry!**





Tylor Patent Pit-Type Furnace.

OUTPUT.
200 lbs. Admiralty Gunmetal melted in 35 minutes. Temperature 2000° F.=1093° C.

ECONOMY.
25 lbs. of Coke used per 200 lbs. of Metal melted.

STANDARD CRUCIBLES.
Lasting 35 to 40 heats.

Tylor Patent Tilting-Type Furnace.

OUTPUT.
450 lbs. Admiralty Gunmetal melted in 50 minutes. Temperature 2000° F.=1093° C.

ECONOMY.
80 lbs. of Coke used per 450 lbs. of Metal melted.

STANDARD CRUCIBLES.
Lasting 30 to 40 heats.

56/8, EAGLE STREET, SOUTHAMPTON ROW, LONDON, W.C.1.

Works: TOTTENHAM, LONDON, N.17.

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash ..	68 5 0
Three months.. ..	67 15 0
Electrolytic	73 0 0
Tough	70 10 0
Best selected	71 0 0
Sheets	120 0 0
India	120 0 0
Wire bars	74 15 0
Do. April	74 0 0
Do. May	74 0 0
Ingot bars	73 0 0
H.C. wire rods.. ..	80 0 0
Off. aver. cash, Feb.	71 0 9
Do. 3 mths., Feb..	70 14 10½
Do. Settlement Feb.	71 0 4½
Do. Electro Feb..	76 15 6
Do. B.S., Feb. ..	75 1 10½
Aver. spot, copper.. Feb.	71 0 0
Do. Electro, Feb...	77 12 6
Solid drawn tubes ..	17d.
Brazed tubes	17d.
Wire	14½d.
Yellow metal rods..	9½d.
Do. 4x4 Squares ..	12d.
Do. 4x3 Sheets ..	12d.

BRASS.

Solid drawn tubes..	14½d.
Brazed tubes	17½d.
Rods	13½d.
Sheets to 10 w.g. ..	13d.
Wire	12½d.
Rolled metal ..	12½d.

TIN.

	£ s. d.
Standard cash ..	158 0 0
Three Months.. ..	162 0 0
English	156 10 0
Bars	158 10 0
Chinese	152 10 0
Straits	185 13 9
Australian	169 10 0
Eastern	203 0 0
Banca	181 10 0
Off. aver., cash, Feb.	166 9 1½
Do. 3 mths., Feb ..	170 16 3
Do. Sttlment., Feb.	166 6 6
Aver. spot, Feb ..	166 5 3

SPELTER.

	£ s. d.
Ordinary	23 15 0
Remelted	19 10 0
Hard	17 0 0
Electro 99.9	33 5 0
English	27 0 0
India	21 0 0
Prime Western ..	24 5 0
Zinc dust	60 0 0
Zinc ashes	6 5 0
Off. aver., Feb. ..	25 5 5½
Aver., spot, Feb. ..	22 17 0

LEAD.

	£ s. d.
Soft foreign ppt ..	17 10 0
English	19 10 0
Off. average, Feb...	21 0 0
Average spot, Feb.	20 13 7½

ZINC SHEETS.

	£ s. d.
Zinc sheets, spot ..	37 0 0
Do. V.M. ex. whf	38 0 0
Do. ppt., f.o.b., N.Y.	—
Dutch	37 0 0
Boiler plates	34 10 0
Battery plates ..	33 10 0

ANTIMONY.

	£ s. d.
English regulus ..	37 5 0
Special brands ..	42 0 0
Chinese	23 10 0
Crude	20 0 0

QUICKSILVER.

	£ s. d.
Quicksilver.	12 5 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	18 10 0
75%	28 0 0
Ferro-vanadium—	
35/40% ..	27/6 lb. va.
Ferro-molybdenum—	
70/80% ..	7/9 lb. mo.
Ferro-titanium—	
23/25%, carbonless	1/9 lb.
Ferro-phosphorus, 20/23%,	£38
Ferro-tungsten—	
80/85%, carbon free	1/11 lb.
Tungsten metal powder—	
98/99%	3/- lb.
Ferro-chrome—	
4/6% car.	£37 10
6/8% car.	£37
8/10% car. ..	£36 10
Ferro-chrome—	
Max. 2% car. ..	£86
Max. 1% car. ..	£102
Max. 0.75% car. ..	£120
65/75% carbonless	3/- lb.
Nickel—99·8% cubes or pellets ..	£205
Cobalt metal—97% ..	20/- lb.
Aluminium—98/99%	£150
Metallic Chromium—	
98/99%	6/6 lb.
Ferro-manganese—	
76/80%, loose ..	£25
76/80%, packed ..	£26
76/80%, export ..	£22 10
Metallic manganese—	
98/99%, carbonless	3/3 lb.
Per ton unless otherwise stated.	

HIGH-SPEED TOOL STEEL.

	s. d.
Finished bars, 14% tungsten	3 2
Finished bars, 18% tungsten	4 0
Scrap pieces	5d.
Turnings and swarf..	3d.
Per lb. net, d/d buyers' works.	
Extras—	
Rounds and squares 3 in. to 8 in. inclusive	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness	3d. lb.
Bevels of approved sizes and sections ..	6d. lb.
If in coils	3d. lb.
Packing	4s. cwt
Bars cut to length	10% extra
Scrap from high-speed tool steel—	
Scrap pieces	5d.
Turnings and swarf ..	3d.
Per lb. net, d/d steel makers' works.	

SCRAP.

South Wales—	£ s. d.	£ s. d.
Heavy Steel	4 10 0	
Bundled steel & shearings	4 0 0	
Mixed iron & steel ..	2 0 0	4 10 0
Heavy cast iron ..		5 10 0
Good machinery for foundries ..		8 10 0
Cleveland—		
Heavy steel ..		4 10 0
Steel turnings ..		3 17 6
Cast-iron borings		3 17 6
Heavy wrought iron piling ..		7 5 0
Bundling scrap ..		6 15 0
Cast-iron scrap ..		8 10 0
Lancashire—		
Cast iron scrap ..		9 5 0
Heavy wrought ..		6 0 0
Steel turnings ..		3 15 0
London—		
Copper (clean) ..		55 0 0
Brass (clean) ..		34 0 0
Lead (less usual draft)		16 0 0
Tea lead		13 0 0
Zinc		13 0 0
New aluminium cuttings ..		70 0 0
Braziery copper ..		45 0 0
Gun metal ..		49 0 0
Hollow pewter ..		120 0 0
Shaped black pewter		80 0 0

PIG-IRON.

N.-E. Coast—	
Foundry No. 1 ..	155/-
Foundry No. 3 ..	150/-
Forge No. 4	149/-
Mottled	147/6
Hematite No. 1 ..	182/6
Hematite M/Nos. ..	180/-
Midlands—	
Staffs. common ..	195/-
,, part-mine forge	210/-
,, ,, foundry	220/-
,, Cold blast ..	360/-
,, basic	195/-
Northants forge	192/6—217/6
,, foundry No. 3	195/-
,, basic.. ..	190/-
Derbyshire forge ..	190/-
,, foundry No. 3	195/-
,, basic ..	190/-
Scotland—	
Foundry No. 1 ..	225/-
,, No. 3 ..	220/-
Hematite M/Nos. ..	220/-
Sheffield (d/d district)—	
Derby forge	—
,, foundry No. 3	—
,, basic	—
Lincs. forge	215/-
,, foundry No. 3	220/-
,, basic	187/6
E.C. hematite ..	193/-
W.C. hematite ..	236/-
All d/d in the district.	
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, foundry No. 3	—
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry..	247/6
Glengarnock foundry	247/6
Gartsherrie foundry	247/6
Monkland foundry ..	247/6

FINISHED IRON & STEEL.

Iron—	£ s.	£ s. d.
Bars (cro'n)	23 0	26 10 0
Angles ..	23 10	27 0 0
Tees to 3 united ins. ..	24 0	27 10 0
Nut and bolt ..		26 10 0
Hoops		26 5 0
Marked bars (Staffs.) ..		29 10 0
Gas strip ..		29 10 0
Bolts and nuts, ¾ in. × 4 in.		49 0 0
Steel—		
Ship plates ..		21 0 0
Boiler plates ..		27 10 0
Checquer plates		24 0 0
Angles		19 10 0
Tees		20 10 0
Channels ..		19 10 0
Joists		19 0 0
Rounds, ¾ in.–3-in.		19 0 0
Rounds, 3 in.–5½ in.		18 0 0
Flats, 5 in.–8 in.		18 10 0
Flats over 8 in.		18 0 0
Rails, heavy ..		18 0 0
Fishplates ..		23 0 0
Hoops		20 0 0
Black sheets, 24 g.		24 10 0
Galv. cor. sheets, 24 g.		24 10 0
Galv. fencing wire, 8 g. plain ..		30 10 0
Rivets, ¾ in. dia		36 0 0
Billets, soft ..		13 10 0
Billets, hard ..		14 10 0
Sheet and tin bars		14 10 0

PHOSPHOR BRONZE.

Rolled.	Per lb. s. d.
½ in. to 1 in. wide ..	2 0½
1 in. to 1½ in. wide ..	1 11½
1½ in. to 2 in. wide ..	1 10½

Strips.	s. d.
2 in. to 6 in. to 26 S.W.G.	1 9½
6 in. to 12 in. to 26 S.W.G.	1 9½

Sheets.	s. d.
12 in. to 18 in. to 24 S.W.G.	1 10
18 in. to 24 in. to 24 S.W.G.	1 10½
24 in. to 30 in. to 20 S.W.G.	1 11½
30 in. to 36 in. to 16 S.W.G.	2 0½
36 in. to 42 in. to 16 S.W.G.	2 1½

Extras.

For Gauge: Any width up to 36 in. wide, ½d. per lb. per thinner gauge.

Drawn Rods.	s. d.
¼ in. to ½ in. dia. in random lengths / 5/16 in. to 1½ in. dia. in random lengths	1 10½
Over 1½ in. to 1⅝ in. ..	1 10½
Tubes—basis price ..	2 0½

Delivery 2 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	1/3 to 1/9
Rolled—	
To 9 in. wide	1/10½ to 2/4½
To 12 in. wide	1/11 to 2/5
To 15 in. wide	2/- to 2/6
To 18 in. wide	2/1 to 2/7
To 21 in. wide	2/2 to 2/8
To 24 in. wide	2/3 to 2/9
Ingots for spoons and forks ..	1/3 to 1/9
Ingots rolled to spoon size ..	1/6 to 2/-
Wire round—	
3/0 to 10. G. ..	2/1 to 2/8

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	30.09
No. 2 foundry Valley..	29.00
No. 2 foundry, Birm. ..	27.50
Basic	26.96
Bessemer	28.96
Malleable	29.96
Grey forge	28.96
Ferro-manganese, Atlantic port	90.00
Bess. rails, h'y, at mill	45.00
O.-h. rails, h'y, at mill	47.00
Bess. billets	43.50
O.-h. billets	38.50
O.-h. sheet bars ..	42.00
Wire rods	52.00
	Cents.
Iron bars, Phila. ..	2.70
Steel bars	2.00
Tank plates	2.25
Beams, etc.	2.20
Skelp, grooved steel ..	2.45
Skelp, sheared steel ..	2.65
Steel hoops	2.80
Sheets, black, No. 28 ..	4.15
Sheets, galv., No. 28 ..	5.25
Sheets, blue an'l'd, 9&10	3.20
Wire nails	3.10
Plain wire	3.00
Barbed wire, galv. ..	4.00
Tinplate, 100-lb. box ..	$7.00

COKE.

Welsh foundry	72/6
,, furnace	57/6
Durham & North foundry	70/-
,, furnace	54/6
Other Districts, foundry	77/9
,, furnace	55/-

SWEDISH IRON.

Bars, hammered basis sizes ..	Basis price. £ s. d.	
Rolled Ordinary—Assortment ..	31 0 0 to 38 0 0	
Nail Rods—Square, round and flats ..		
Keg Steel / Faggot Steel	about £50	Prices nominal.

Blooms—
Single welded .. £20 to £25

Billets—
Single and double welded .. £22 to £27

Pig-Iron—
Grey, white or mottled .. £15 to £20

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 2 in.	Over 2 in.
Gas ..	— 5%	—10%
Water ..	+ 5%	— 2¼%
Steam ..	+16¼%	+ 8¾%

REFRACTORIES.

	£	s.	d.
Magnesite bricks, 2½ in., d/d	137	10	0
Do. 3 in., d/d	165	0	0
Common firebricks, 2½ in., d/d	10	0	0
Do. 3 in., d/d	12	0	0
Scotch firebricks, 2½ in., f.o.r.	12	15	0
Do. 3 in., f.o.r.	15	7	6
Sheffield quality, 2½ in., f.o.r.	11	0	0
Do. 3 in., f.o.r.	13	5	0
Silica bricks (ord.), 2½ in., f.o.r.	14	18	6
Do. 3 in., f.o.r.	17	18	6

All per 1,000 bricks.

Basic Dolomite ..	3	18	0
Dead burnt magnesite (peas and powder), d/d ..	26	0	0
Ground fireclay	1 10 0 to 2	0	0
Ganister	1 10 0 to 1	12	6

TINPLATES.

I.C. Cokes, 20×14, box	30/-
,, 28×20, ,,	60/-
,, 20×10, ,,	46/-
,, 18¾×14, ,,	34/-
Terneplates, 28×20, ,,	60/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
Feb. 23	70	15	0	No change
,, 24	70	0	0	dec. 15/-
,, 25	69	5	0	,, 20/-
,, 28	68	5	0	,, 20/-
Mar. 1	68	5	0	No change

Standard Tin (cash).

Feb. 23	169	0	0	dec. 20/-
,, 24	168	10	0	,, 10/-
,, 25	165	10	0	,, 60/-
,, 28	159	10	0	,, 120/-
Mar. 1	158	0	0	,, 30/-

Zinc Sheets (spot).

Feb. 23	38	0	0	No change
,, 24	38	0	0	No change
,, 25	37	0	0	dec. 20/-
,, 28	37	0	0	No change
Mar. 1	37	0	0	No change

Spelter (ordinary).

Feb. 23	25	7	6	inc. 5/-
,, 24	25	10	0	,, 2/6
,, 25	23	15	0	dec. 35/-
,, 28	23	15	0	No change
Mar. 1	23	15	0	No change

Lead (English).

Feb. 23	20	15	0	dec. 15/-
,, 24	20	10	0	,, 5/-
,, 25	19	0	0	,, 30/-
,, 28	19	10	0	inc. 10-
Mar. 1	19	10	0	No chang

SHROPSHIRE IRON Co., Ltd.

Works — Hadley, Shropshire.
London: 10, Bush Lane, Cannon St., E.C.4.
Telegrams:— Sun, Wellington, Salop. Sunbrand (Cannon), London.
Telephone:— 11 Wellington, Salop. 5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.
Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.
Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.
BEST H. C. COPPER & BRONZE WIRE a speciality.
Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

ROBERT HEATH & LOW MOOR, LIMITED, Stoke-on-Trent.

B.B.H. IRON. At works. BARS, ANGLES, TEES and PLATES.
R.H. ♔ IRON. Delivered F.O.B. Liverpool, BARS, ANGLES, TEES and PLATES.
HOOPS delivered F.O.B. Liverpool.
IRON R.D. ♔ RAVENSDALE (Best)
MILD STEEL (up to 2in. wide) Marked "HEATH'S SOFT STEEL."
Prices on Application.

WILLIAM JACKS & COMPANY,
5, EAST INDIA AVENUE, LONDON, E.C.3.

Telegrams: ALKALIZE, BIRMINGHAM.
Telephone: CENTRAL 1175 & 1176
Birmingham Office:
18, BENNETT'S HILL.

Telegrams: ALKALIZE, LONDON.
Telephone: 7860 AVENUE (3 lines.
Head Office:
5, EAST INDIA AVENUE, London, E.C.

REGISTERED TRADE MARK
LIMPET

PIG IRON.

Scotch, Middlesbro,' Hematite, Basic, Specials, &c., &c.

TIN — SPELTER — CHROME
COPPER — ANTIMONY—MANGANESE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS.

ADVERTISER covering London district and South-Eastern Counties, desires to represent works, or first-class merchants, for Plates, Sheets, Merchant Sections, Pig-iron, Bright Bars, etc.; good connection, and thorough knowledge of the trades.—Reply, Box 690, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

SCRAP IRON AND STEEL.—Gentleman is open to co-operate with sound, competitive merchant on profit-sharing terms.—Reply, Box 688, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

ENGINEER REPRESENTATIVE, age 30 years, open for re-engagement; would consider representing two firms or one only; well connected amongst engineers, etc.; experienced in all engineers' requirements and foundry plant; Lancashire and Yorkshire ground preferred, but not essential. Would be pleased to entertain the Colonies or U.S.A., having successfully worked New York. Highest references from important firms.—HALL, 48, Withnell Road, Blackpool.

REQUIRED, TRAVELLER for Cast-Iron Castings, one experienced in the trade preferred, and with good connection amongst Engineers.—Reply, stating salary and commission required, to Box 692, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

BRASS FOUNDRY FOREMAN (working), to take charge of about 30 hands, must be thoroughly experienced in all methods of foundry and finishing. Works about 30 miles from London. Rooms on premises.—Reply, stating age, wages, experience, and when disengaged.—Box No. 123, c/o Messrs. Industrial Publicity, Limited, 4-7 Red Lion Court, Fleet Street, E.C

AGENCY.

FIRM OF AGENTS in South Wales, closely connected with the Tinplate Trade, wishes to represent in that area manufacturers of Chilled and Grain Rolls.—Correspondence to Box No. 686, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MISCELLANEOUS.

LIMESTONE, Raw for Blast Furnaces, etc. Finest Quality.—Prices from KNOWLE LIME WORKS, Presthorpe, Salop.

STRONG ERITH FOUNDRY LOAM on Rail in Truck loads.—Sample and quotation from T. C. BUCKLEY, Sand Pits, Erith.

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MACHINERY.

TURN TO THE B.W.S. ANNOUNCEMENT, PAGE 11.

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